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ABSTRACT

This student guide, one of a series of correspondence training courses designed to improve the job performance of members of the Marine Corps, deals with the skills needed by bulk fuel workers. Addressed in the four individual units of the course are the following topics: bulk fuel equipment, bulk fuel systems, procedures for handling fuels, and safety and firefighting equipment and procedures. Each unit contains a general objective, a series of work units addressing a different subobjective, study questions, and answers to the study questions. Appendixes to the guide contain a glossary and information on equipment. A handbook for bulk fuel workers is also included with the guide. (MN)

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13.37g

1. ORIGIN

MCI course 13.37g, Bulk Fuel Man, has been prepared by the Marine Corps Institute.

2. APPLICABILITY

This course is for instructional purposes only.

JMD Holladay
J. M. D. HOLLADAY
Lieutenant Colonel, U. S. Marine Corps
Deputy Director

BEST COPY

ACKNOWLEDGMENT

The Marine Corps Institute, Marine Barracks, Washington, D. C. gratefully acknowledges the important contributions provided by the following MCI personnel in developing and publishing this course.

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INFORMATION

FOR

MCI STUDENTS

Welcome to the Marine Corps Institute training program. Your interest in self-improvement and increased professional competence is commendable.

Information is provided below to assist you in completing the course. Please read this guidance before proceeding with your studies.

1. MATERIALS

Check your course materials. You should have all the materials listed in the "Course Introduction." In addition you should have an envelope to mail your review lesson back to MCI for grading unless your review lesson answer sheet is of the self-mailing type. If your answer sheet is the pre-printed type, check to see that your name, rank, and social security number are correct. Check closely, your MCI records are kept on a computer and any discrepancy in the above information may cause your subsequent activity to go unrecorded. You may correct the information directly on the answer sheet. If you did not receive all your materials, notify your training NCO. If you are not attached to a Marine Corps unit, request them through the Hotline (autovon 288-4175 or commercial 202-433-4175).

2. LESSON SUBMISSION

The self-graded exercises contained in your course are not to be returned to MCI. Only the completed review lesson answer sheet should be mailed to MCI. The answer sheet is to be completed and mailed only after you have finished all of the study units in the course booklet. The review lesson has been designed to prepare you for the final examination.

It is important that you provide the required information at the bottom of your review lesson answer sheet if it does not have your name and address printed on it. In courses in which the work is submitted on blank paper or printed forms, identify each sheet in the following manner:

DOE, John J. Sgt 332-11-9999
08.4g, Forward Observation
Review Lesson
Military or office address
(RUC number, if available)

Submit your review lesson on the answer sheet and/or forms provided. Complete all blocks and follow the directions on the answer sheet for mailing. Otherwise, your answer sheet may be delayed or lost. If you have to interrupt your studies for any reason and find that you cannot complete your course in one year, you may request a single six month extension by contacting your training NCO, at least one month prior to your course completion deadline date. If you are not attached to a Marine Corps unit you may make this request by letter. Your commanding officer is notified monthly of your status through the monthly Unit Activity Report. In the event of difficulty, contact your training NCO or MCI immediately.

3. MAIL-TIME DELAY

Presented below are the mail-time delays that you may experience between the mailing of your review lesson and its return to you.

	TURNAROUND MAIL TIME	MCI PROCESSING TIME	TOTAL NUMBER DAYS
EAST COAST	16	5	21
WEST COAST	16	5	21
FPO NEW YORK	18	5	23
FPO SAN FRANCISCO	22	5	27

You may also experience a short delay in receiving your final examination due to administrative screening required at MCI.

4. GRADING SYSTEM

LESSONS			EXAMS	
GRADE	PERCENT	MEANING	GRADE	PERCENT
A	94-100	EXCELLENT	A	94-100
B	86-93	ABOVE AVERAGE	B	86-93
C	78-85	AVERAGE	C	78-85
D	70-77	BELOW AVERAGE	D	65-77
NL	BELOW 70	FAILING	F	BELOW 65

You will receive a percentage grade for your review lesson and for the final examination. A review lesson which receives a score below 70 is given a grade of NL (no lesson). It must be resubmitted and PASSED before you will receive an examination. The grade attained on the final exam is your course grade, unless you fail your first exam. Those who fail their first exam will be sent an alternate exam in which the highest grade possible is 65%. Failure of the alternate will result in failure of the course.

5. FINAL EXAMINATION

ACTIVE DUTY PERSONNEL: When you pass your REVIEW LESSON, your examination will be mailed automatically to your commanding officer. The administration of MCI final examinations must be supervised by a commissioned or warrant officer or a staff NCO.

OTHER PERSONNEL: Your examination may be administered and supervised by your supervisor.

6. COMPLETION CERTIFICATE

The completion certificate will be mailed to your commanding officer and your official records will be updated automatically. For non Marines, your completion certificate is mailed to your supervisor.

7. RESERVE RETIREMENT CREDITS

Reserve retirement credits are awarded to inactive duty personnel only. Credits awarded for each course are listed in the "Course Introduction." Credits are only awarded upon successful completion of the course. Reserve retirement credits are not awarded for MCI study performed during drill periods if credits are also awarded for drill attendance.

8. DISENROLLMENT

Only your commanding officer can request your disenrollment from an MCI course. However, an automatic disenrollment occurs if the course is not completed (including the final exam) by the time you reach the CCD (course completion deadline) or the ACCD (adjusted course completion deadline) date. This action will adversely affect the unit's completion rate.

9. ASSISTANCE

Consult your training NCO if you have questions concerning course content. Should he/she be unable to assist you, MCI is ready to help you whenever you need it. Please use the Student Course Content Assistance Request Form (ISD-1) attached to the end of your course booklet or call one of the AUTOVON telephone numbers listed below for the appropriate course writer section.

PERSONNEL/ADMINISTRATION	288-3259
COMMUNICATIONS/ELECTRONICS/AVIATION NBC/INTELLIGENCE	288-3604
INFANTRY	288-3611
ENGINEER/MOTOR TRANSPORT	288-2275
SUPPLY/FOOD SERVICES/FISCAL	288-2285
TANKS/ARTILLERY/INFANTRY WEAPONS REPAIR LOGISTICS/EMBARKATION/MAINTENANCE MANAGEMENT/ ASSAULT AMPHIBIAN VEHICLES	288-2290

For administrative problems use the UAR or call the MCI HOTLINE: 288-4175.

For commercial phone lines, use area code 202 and prefix 433 instead of 288.

PREFACE

The objective of BULK FUEL MAN is to provide coverage of the job for the Marine who is now or who will be filling the billet as a bulk fuel man. This course emphasizes characteristics, maintenance, quality assurance, site construction, safety, and firefighting and prevention. This course also covers usage of bulk fuel equipment as identified in the different systems of bulk fuel. This course should precede course 13.39, Maintenance of Bulk Fuel Equipment, as this is an introductory course; whereas, 13.39 is more advanced, covering trouble-shooting and maintenance procedures in more detail.

SOURCE MATERIALS

FMFM 4-4	Marine Engineer Operations
FM 10-18	Petroleum Terminal and Pipeline Operations, 31 Oct 1967
FM 10-69	Petroleum Supply Point Equipment and Operations, 30 Jun 1977
FM 10-207	Petroleum Pipeline and Terminal Operating Company, 10 Apr 1981
FM 10-277	Petroleum Supply Company, 28 Sep 1979
FM 10-70	Inspecting and Testing Petroleum Products, 30 Jul 1976
NAVAIR 19-1-94	Fuel Dispensing, Expedient Refueler Pump Assembly, Oct 1967
NAVAIR 19-1-107	Helicopter Fuel Servicing System, 1 Jan 1969 w/Ch A and B
TM-3835-15/1	Amphibious Assault Fuel System and Tactical Airfield Fuel Dispensing System, Oct 1978
TM-07661A-14	Extinguisher, Fire, Dry Chemical, Aqueous Film-Forming Foam, Mar 1976
TM-5-4320-256-14	Pump Assembly, Flammable, Liquid, Centrifugal, 100 GPM, Nov 1974 w/Ch-1, 2, A
TM 10-1101	Petroleum Handling Equipment and Operations, May 1972
SL-3-07387C	Helicopter Expedient Refueling System, Sep 1982
SL-3-06674C	Fuel System, Amphibious Assault, Dec 1982
TM-0787B-14	Helicopter Expedient Refueling System (HERS), 31 Oct 1973 w/Ch-1
TM-11275-15/3A	Principal Technical Characteristics of U. S. Marine Corps Engineer Equipment, Jul 1981

BULK FUEL MAN

Course Introduction

During World War II, the fuel needs of the Marine Amphibious Forces were barely met with 5-gallon cans and 55-gallon drums, placing a huge burden on the beach personnel. At the direction of the Commandant, the Marine Corps Equipment Board (forerunner of the Development Center) developed a concept in 1952 for fuel delivery in amphibious operations. The concept proved workable and evolved into the Amphibious Assault Fuel System (AAFS), the Tactical Airfield Fuel Dispensing System (TAFDS), and the Helicopter Expedient Refueling System (HERS). The basic and most significant feature of the three systems is flexibility, in that no tools are needed to assemble the AAFS, TAFDS, or HERS. The system required can be tailored to the needs of the tactical situation, and its components hooked up using the quick-disconnect cam-locking fittings.

The units to which the bulk fuel man can be attached or assigned are varied according to their missions. The majority of bulk fuel men, in the ground support role, are located within the two Bulk Fuel Companies that are part of the Engineer Support Battalion. The Wing Engineer Squadron, Marine Wing Support Group, provides the majority of the air role with the TAFDS. The Marine Air Base Squadrons and Station Fuels have their own bulk fuel men and their own roles. You must be aware of the different missions and roles that each of these units plays as well as knowing your own job. This course will assist you toward that goal, but you should temper yourself by consulting the source materials for this course. This course is not intended to take the place of your formal education but will further enhance your experience as a bulk fuel man.

ADMINISTRATIVE INFORMATION

ORDER OF STUDIES

Study Unit Number	Study Hours	Subject Matter
1	3	Bulk Fuel Equipment
2	2	Bulk Fuel Systems
3	2	Fuel Handling Procedures
4	2	Safety and Fire Fighting Equipment and Procedures
	2	REVIEW LESSON
	2	FINAL EXAMINATION
	13	

RESERVE RETIREMENT CREDITS:	4
COLLEGE CREDITS:	American Council on Education (ACE) has awarded 13.37g, BULK FUEL MAN, 2 semester hours credit in petroleum oil and lubricants (POL) pipeline operations in the Vocational Certificate Category.
EXAMINATION:	Supervised final examination without textbook or notes; time limit, 2 hours.
MATERIALS:	MCI 13.37g, Bulk Fuel Man, Review Lesson and answer sheet.
RETURN OF MATERIALS:	Students who successfully complete this course are permitted to keep the course materials. Students disenrolled for inactivity or at the request of their commanding officer will return all course materials.

HOW TO TAKE THIS COURSE

This course contains four study units. Each study unit begins with a general objective that is a statement of what you should learn from the study unit. The study units are divided into numbered work units, each presenting one or more specific objectives. Read the objective(s) and then the work unit text. At the end of the work unit text are questions that you should be able to answer without referring to the text of the work unit. After answering the questions, check your answers with those listed at the end of the study unit. If you miss any of the questions, you should restudy the text of the work unit until you understand the correct responses. When you have mastered one study unit, move on to the next. After you have completed all of the study units, complete the review lesson and take it to your training officer or NCO for mailing to MCI. MCI will mail the final examination to your training officer or NCO when you pass the review lesson.

TABLE OF CONTENTS

	Work Unit	Page
Preface		i
Source Materials		i
Course introduction		iii
Table of contents		v
Study guide		vii

Study Unit 1. BULK FUEL EQUIPMENT

	Work Unit	Page
50-GPM pump	1-1	1-1
100-GPM pump	1-2	1-2
350-GPM pump	1-3	1-4
600-GPM pump	1-4	1-5
Hose and hose accessories	1-5	1-6
50-GPM filter-separator	1-6	1-8
100-GPM filter-separator	1-7	1-9
350-GPM filter-separator	1-8	1-12
Fuel monitor	1-9	1-13
The fuel meter/register	1-10	1-14
Pressure regulator	1-11	1-15
Fuel manifold	1-12	1-17
20,000-gallon collapsible tank	1-13	1-19
500-gallon drum	1-14	1-20
Emergency repair kit/general repair kit	1-15	1-22
Bulk fuel hardware	1-16	1-25

Study Unit 2. BULK FUEL SYSTEMS

	Work Unit	Page
Bulk fuel system site selection	2-1	2-1
Site construction and installation	2-2	2-5
Amphibious Assault Fuel System (AAFS)	2-3	2-9
Tactical Airfield Fuel Dispensing System (TAFDS)	2-4	2-11
Helicopter Expedient Refueling System (HERS)	2-5	2-14
High Speed Fixed Refueling System	2-6	2-16
Expedient Refueler System (ERS)	2-7	2-26

Study Unit 3. FUEL HANDLING PROCEDURES

	Work Unit	Page
Fuel transfer procedures	3-1	3-1
Quality control procedures	3-2	3-4
Fuel storage techniques	3-3	3-6
Fuel sampling procedures	3-4	3-7
Tests of petroleum samples	3-5	3-8

Study Unit 4. SAFETY AND FIREFIGHTING EQUIPMENT AND PROCEDURES

	Work Unit	Page
Safety guidelines for bulk fuel	4-1	4-1
Fire prevention	4-2	4-5
Firefighting truck MC1051	4-3	4-6
Fire extinguishers and maintenance	4-4	4-11
The twin-agent unit fire extinguisher	4-5	4-16
Firefighting methods	4-6	4-21

Appendix A

	Work Unit	Page
Equipment Development		A 1
Glossary		A 2

MARINE CORPS INSTITUTE

STUDY GUIDE

Welcome to the Marine Corps Institute correspondence training program. By enrolling in this course, you have shown a desire to improve the skills you need for effective job performance, and MCI has provided materials to help you achieve your goal. Now all you need is to develop your own method for using these materials to best advantage.

The following guidelines present a four-part approach to completing your MCI course successfully:

1. Make a "reconnaissance" of your materials;
2. Plan your study time and choose a good study environment;
3. Study thoroughly and systematically;
4. **Prepare** for the final exam.

I. MAKE A "RECONNAISSANCE" OF YOUR MATERIALS

Begin with a look at the course introduction page. Read the COURSE INTRODUCTION to get the "big picture" of the course. Then read the MATERIALS section near the bottom of the page to find out which text(s) and study aids you should have received with the course. If any of the listed materials are missing, see Information for MCI Students to find out how to get them. If you have everything that is listed, you are ready to "reconnoiter" your MCI course.

Read through the table(s) of contents of your text(s). Note the various subjects covered in the course and the order in which they are taught. Leaf through the text(s) and look at the illustrations. Read a few work unit questions to get an idea of the types that are asked. If MCI provides other study aids, such as a slide rule or a plotting board, familiarize yourself with them. Now, get down to specifics!

II. PLAN YOUR STUDY TIME AND CHOOSE A GOOD STUDY ENVIRONMENT

From looking over the course materials, you should have some idea of how much study you will need to complete this course. But "some idea" is not enough. You need to work up a personal study plan; the following steps should give you some help.

Ⓐ Get a calendar and mark those days of the week when you have time free for study. Two study periods per week, each lasting 1 to 2 hours, are suggested for completing the minimum two study units required each month by MCI. Of course, work and other schedules are not the same for everyone. The important thing is that you schedule a regular time for study on the same days of each week.

Ⓑ Read the course introduction page again. The section marked ORDER OF STUDIES tells you the number of study units in the course and the approximate number of study hours you will need to complete each study unit. Plug these study hours into your schedule. For example, if you set aside two 2-hour study periods each week and the ORDER OF STUDIES estimates 2 study hours for your first study unit, you could easily schedule and complete the first study unit in one study period. On your calendar you would mark "Study Unit 1" on the appropriate day. Suppose that the second study unit of your course requires 3 study hours. In that case, you would divide the study unit in half and work on each half during a separate study period. You would mark your calendar accordingly. Indicate on your calendar exactly when you plan to work on each study unit for the entire course. Do not forget to schedule one or two study periods to prepare for the final exam.

Ⓒ Stick to your schedule.

Besides planning your study time, you should also choose a study environment that is right for you. Most people need a quiet place for study, like a library or a reading lounge; other people study better where there is background music; still others prefer to study out-of-doors. You must choose your study environment carefully so that it fits your individual needs.

III. STUDY THOROUGHLY AND SYSTEMATICALLY

Armed with a workable schedule and situated in a good study environment you are now ready to attack your course study unit by study unit. **To begin, turn to the first page of study unit 1. On this page you will find the study unit objective, a statement of what you should be able to do after completing the study unit.**

DO NOT begin by reading the work unit questions and flipping through the text for answers. If you do so, you will prepare to fail, not pass, the final exam. Instead, proceed as follows:

Ⓐ Read the objective for the first work unit and then read the work unit text carefully. Make notes on the ideas you feel are important.

Ⓑ Without referring to the text, answer the questions at the end of the work unit.

Ⓒ Check your answers against the correct ones listed at the end of the study unit.

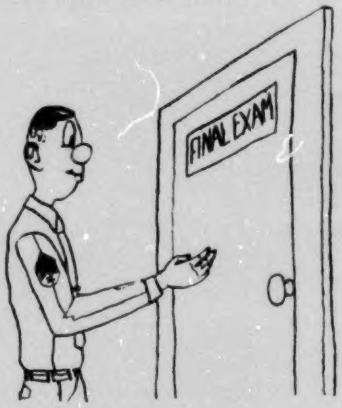
Ⓓ If you miss any of the questions, restudy the work unit until you understand the correct response.

Ⓔ Go on to the next work unit and repeat steps Ⓐ through Ⓓ until you have completed all the work units in the study unit.

Follow the same procedure for each study unit of the course. If you have problems with the text or work unit questions that you cannot solve on your own, ask your section OIC or NCOIC for help. If he cannot aid you, request assistance from MCI on the Student Course Content Assistance Request included with this course.

When you have finished all the study units, complete the course review lesson. Try to answer each question without the aid of reference materials. However, if you do not know an answer, look it up. When you have finished the lesson, take it to your training officer or NCO for mailing to MCI. MCI will grade it and send you a feedback sheet listing course references for any questions that you miss.

IV. PREPARE FOR THE FINAL EXAM



How do you prepare for the final exam? Follow these four steps:

Ⓐ Review each study unit objective as a summary of what was taught in the course.

Ⓑ Reread all portions of the text that you found particularly difficult.

Ⓒ Review all the work unit questions, paying special attention to those you missed the first time around.

Ⓓ Study the course review lesson, paying particular attention to the questions you missed.

If you follow these simple steps, you should do well on the final. GOOD LUCK!

STUDY UNIT 1

BULK FUEL EQUIPMENT

STUDY UNIT OBJECTIVE: WITHOUT THE AID OF REFERENCES, YOU WILL IDENTIFY THE OPERATING CHARACTERISTICS OF BULK FUEL EQUIPMENT. IN ADDITION, YOU WILL IDENTIFY THE PROPER USE OF EQUIPMENT BY ITS NOMENCLATURE, PURPOSE, CAPABILITIES, LIMITATIONS, AND ASSEMBLY PROCEDURES.

Work Unit 1-1. THE 50-GPM PUMP

IDENTIFY TWO CAPABILITIES OF THE 50 GPM PUMP.

50-gpm (gallons per minute) pump. This pump assembly is used as an expedient refueler for field mechanized equipment and fuel transfer. It may be used to dispense fuels from any source, limited by a maximum suction of 10 feet. Two nozzles allow hand control of two separate discharge lines. This pump assembly is also used in the helicopter expedient refueling system (HERS).

Pump assembly, model 803 (fig 1 and 2). This is a frame-mounted centrifugal pump driven by a 1 1/2-horsepower engine. It is provided with one 2-inch suction hose and two 2-inch discharge hoses. The pumping unit, hoses, and other accessories are secured to a metal skid for shipment. The pumping unit impeller is mounted directly on an extension of the engine crankshaft, eliminating the need for an engine-to-pump coupling. The engine and pump are mounted on a welded frame assembly. The pump assembly is designed to pump fuel at the rate of 50 gallons per minute and can fuel two pieces of equipment simultaneously, using the two discharge hoses connected to the cross connector on the pump outlet.

Engine. The 1 1/2-hp engine that powers the pump assembly is a 1-cylinder, air-cooled, 4-stroke-cycle military standard model 1A08-2. It has a 1-gallon capacity fuel tank and the engine muffler is a spark-arresting type to minimize the danger of igniting volatile fuels by exhaust sparks. The muffler is connected to the engine by a 4-foot metal hose.

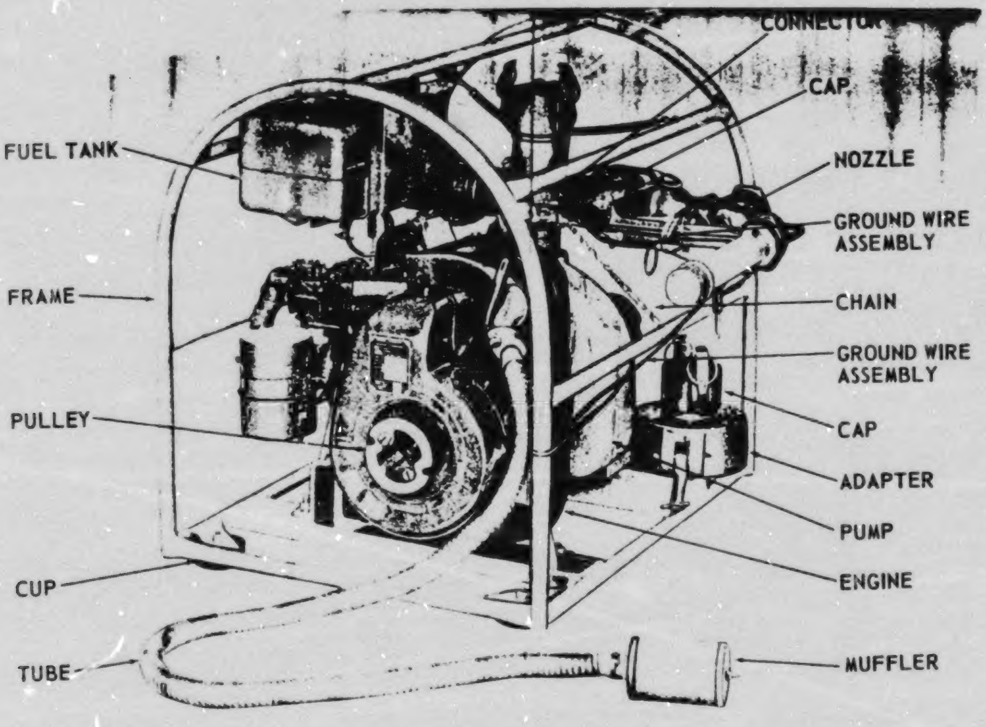


Fig 1-1. Pump assembly, model, 803 removed from skid base.

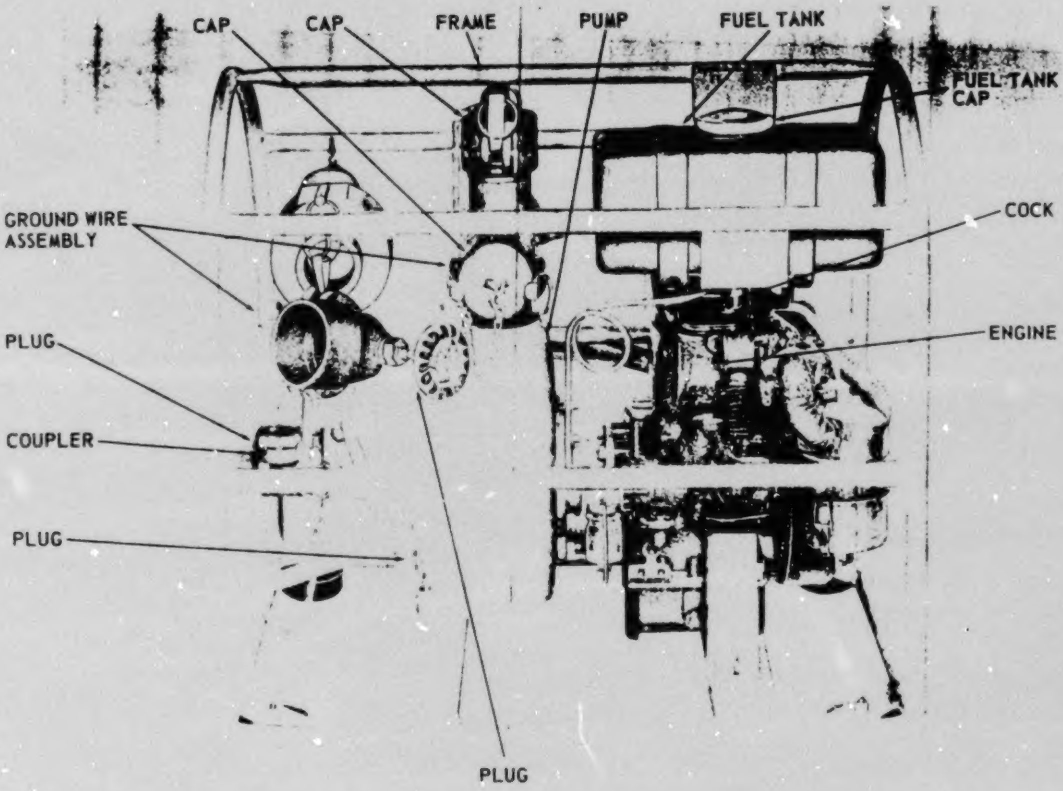


Fig 1-2. Pump assembly, model 803, (side view).

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The maximum suction lift of the 50-gpm expedient refueler is

   a. 10 feet.
   b. 15 feet.
   c. 25 feet.
   d. 100 feet.

2. How many pieces of equipment can be refueled by the 50-gpm expedient refueler at the same time?

   a. Two
   b. Three
   c. Four
   d. Six

Work Unit 1-2. THE 100-GPM PUMP

IDENTIFY TWO CHARACTERISTICS OF THE 100 GPM PUMP.

100-gpm Pump. This pump assembly is an alternate pump in the Helicopter Expedient Refueling System (HERS) and the Fuel Dispensing, Expedient Refueler Pump Assembly. In the future, the 50-gpm pump may be phased out in favor of the 100-gpm pump. The 100-gpm pump is used to pump flammable liquids at the rate of 100 gallons per minute with a maximum suction lift of 25 feet.

Pump Assembly. (figures 1-3 and 1-4). This is a frame-mounted centrifugal pump driven by a 3-horsepower gasoline engine. The pump assembly is equipped with a 2-inch quick disconnect female coupling on the suction side of the pump, and a 2-inch quick disconnect male fitting on the discharge side of the pump.

Engine. The 3-horsepower engine, that powers the pump, is a 2-cylinder, air cooled, 4-stroke-cycle military standard model 2A016-3. It has a 5-gallon fuel can, used as the fuel tank, with an adapter assembly and hose assembly for internal fuel distribution. The engine muffler is a spark arresting type used to minimize the danger of igniting volatile fuel fumes.

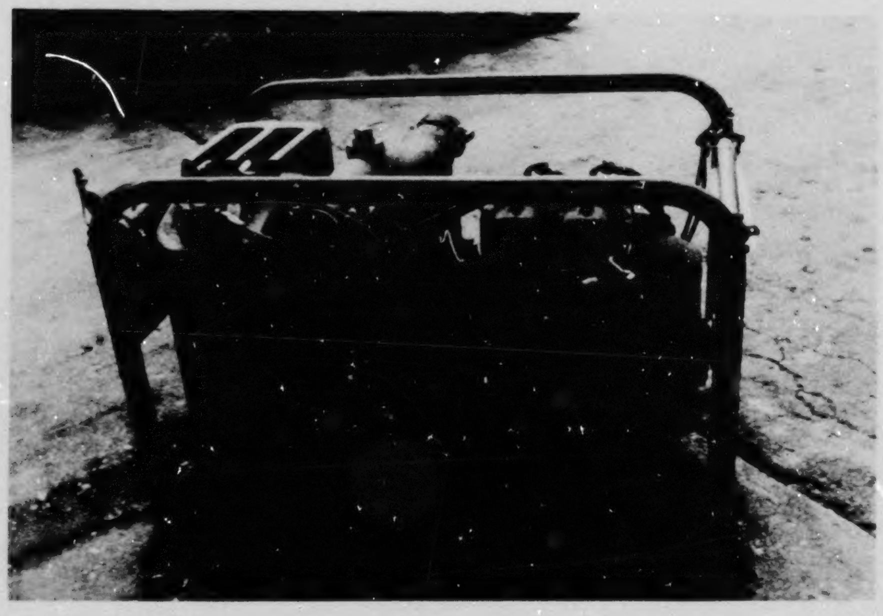


Fig 1-3. 100 GPM Pump (front view).

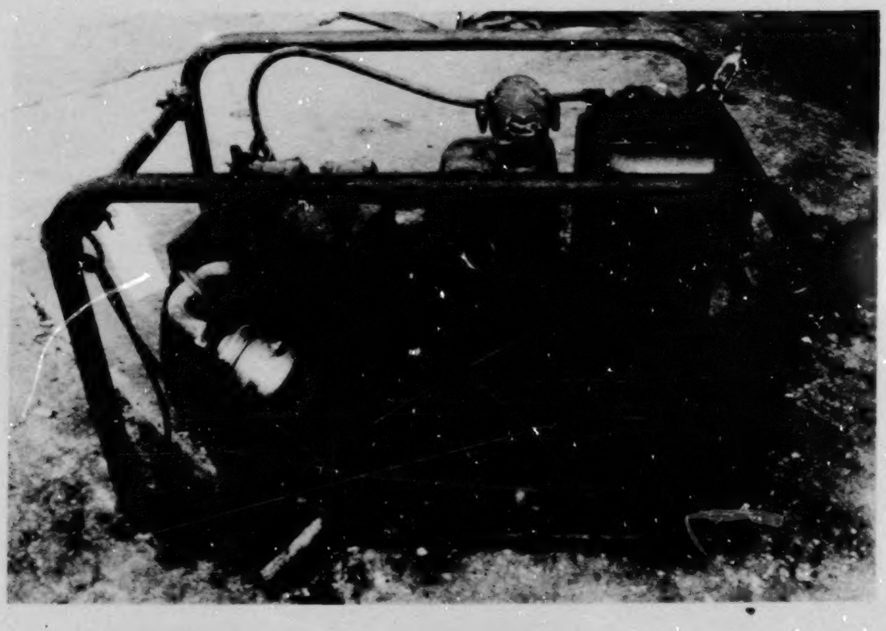


Fig 1-4. 100 GPM Pump (rear view).

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The maximum suction lift of the 100-gpm pump is

a. 10 feet.	c. 20 feet.
b. 15 feet.	d. 25 feet.

2. The 100-gpm pump is used as an alternate pump in the

a. AAF.	c. TAFDS.
b. HERS.	d. AFFF.

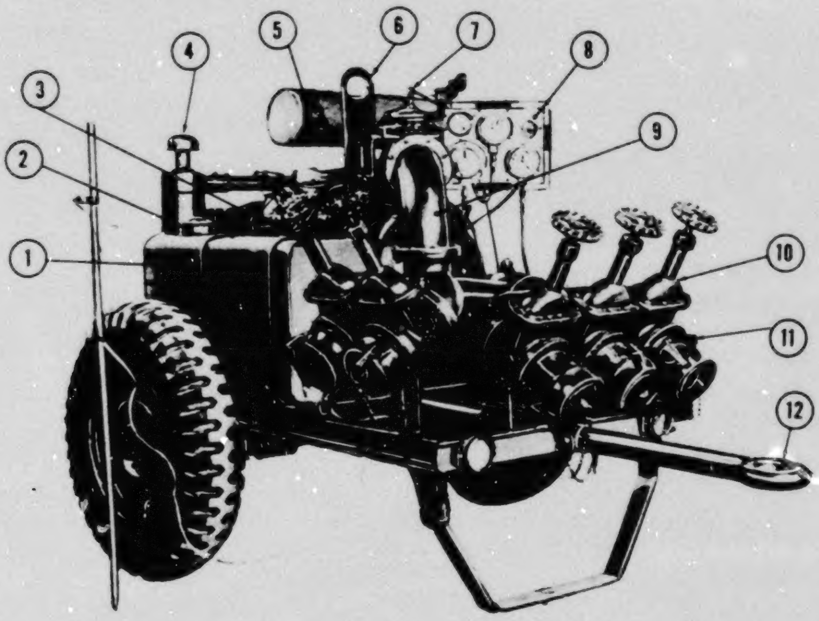
Work Unit 1-3. THE 350-GPM PUMP

IDENTIFY TWO CAPABILITIES OF THE 350 GPM PUMP.

350-gpm centrifugal pump. This pump is a self-contained unit capable of transferring and dispensing fuels from and to storage tanks, vehicles, and aircraft in the field. It is suitable for operation in all weather conditions and is easily transported over rough terrain.

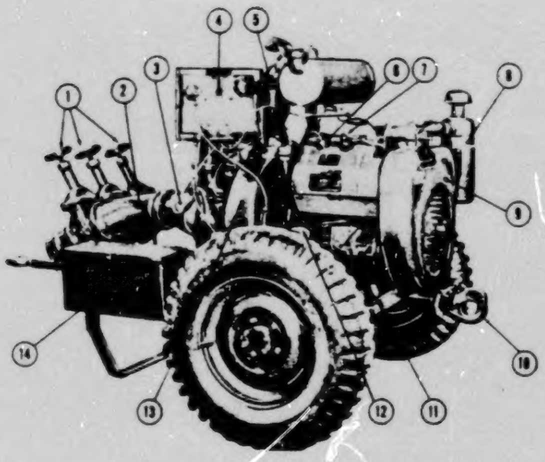
Pump assembly (figure 1-5 and 1-6). The pump is a gasoline-engine-driven, trailer-mounted, self-priming centrifugal pump designed to deliver fuel at 350 gallons per minute at approximately 80 psi (pounds per square inch) discharge pressure. It is equipped with 5 gate valves (3 suction and 2 discharge), all 4 inches in diameter to accommodate hose connections.

Engine. The engine is a 4-cylinder, air-cooled, 4-stroke-cycle, model MVG4D. It is a magneto spark ignition "V" type engine with a rated horsepower of 34.5 at 2,200 rpm (revolutions per minute). The engine is waterproofed for surf and stream fording.



1 Fuel tank
2 Fuel tank cap
3 Right cylinder-head shroud
4 Air cleaner
5 Muffler
6 Lifting eye
7 Air venting valve
8 Control panel
9 Discharge pipe
10 Gate valve, 4 in. (5 reqd)
11 Toolbox
12 Drawbar ring

Fig 1-5. 350-GPM centrifugal pump (pump assembly).



1	Gate valve, 4 in
2	Suction manifold
3	Strainer
4	Control panel
5	Air eliminator
6	Spark plugs (4 required)
7	Ignition cable assembly
8	Air cleaner
9	Front engine panel
10	Pintle hook
11	Magneto
12	Oil filter
13	Pump assembly
14	Toolbox

Fig 1-6. 350-GPM centrifugal pump (pump assembly).

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The discharge pressure of the 350-gpm pump is

   a. 80 psi.
   b. 350 psi.
   c. 100 gallons.
   d. 350 gallons.

2. The 350-gpm pump is equipped with 5 gate valves; __________ are suction and __________ is/are discharge.

   a. 3, 2
   b. 2, 3
   c. 4, 1
   d. 5, 0

Work Unit 1-4. THE 600 GPM PUMP

IDENTIFY TWO CAPABILITIES OF THE 600-GPM PUMP.

600-GPM Pump (fig 1-7). This is the largest pump you will come into contact with. It is a self-contained unit capable of transferring and dispensing fuels to storage tanks, vehicles, and aircraft in the field. It is suitable for operation on the ground and for transportation over all types of terrain under all weather conditions.

Fig 1-7. The 600-GPM Pump.

Pump Assembly. The pump unit is a trailer-mounted, self-priming centrifugal pump. The unit is designed for pumping gasoline, jet fuels, diesel fuels, light liquid petroleum fuels, and water. It is equipped with six gate valves (two 4-inch suction, one 6-inch suction, two 4-inch discharge, and one 6-inch discharge).

Engine. This pump is driven by a 3-cylinder, Detroit Diesel Multifuel diesel engine. The engine is an in-line, 2-cycle, water-cooled type with a 4-exhaust valve head.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The 600-gpm pump is designed to pump 5 liquids. What are they?

a. ____________________
b. ____________________
c. ____________________
d. ____________________
e. ____________________

2. The 600-gpm pump can transfer and dispense fuel to storage tanks, vehicles, and

a. barges.
b. heavy equipment.
c. aircraft.
d. fuel drums.

Work Unit 1-5. HOSES AND HOSE ACCESSORIES

STATE THE FOUR WEAKNESSES OF SUCTION HOSE.

IDENTIFY THE DIFFERENT TYPES OF HOSES.

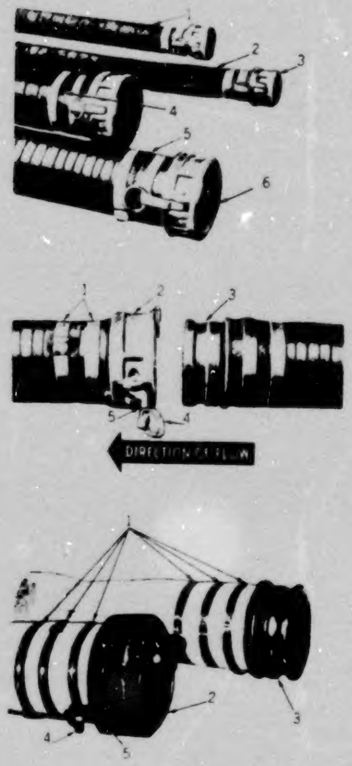
IDENTIFY CAM ACTION DURING THE CONNECTION OF A HOSE.

IDENTIFY ONE WEAKNESS OF THE DISCHARGE HOSE.

You will come into contact with hoses at nearly every fuel system; therefore, you will need to be able to use them correctly. There are two types of hoses that you should be concerned with: suction and discharge hoses. The suction-type hose is wire reinforced and, therefore, non-collapsible. The suction hose is not intended to carry positive pressure but will withstand high vacuum; the discharge hose, on the other hand, will collapse under vacuum conditions, but it is designed to operate at pressures up to 125 psi. Metallic static wires are incorporated in the suction hose, thereby insuring positive electrical bonding between the fittings at each end of the hose. Each section of hose, regardless of length, is fitted with quick-disconnect fittings (fig 1-8); a quick-disconnect adapter (male) in one end and a quick-disconnect coupler half (female) in the other end, secured to the hose by two or three stainless steel bands. Suction hoses are supplied in 2-inch and 4-inch sizes; discharge hoses are supplied in 2-inch, 4-inch, and 6-inch sizes.

All couplings you will see on the hoses will be of the quick-coupling type (fig 1-8) and may be interconnected size for size. In this type of connection, you should insert the female side into the male side and depress the cam arms. This results in cam action which forces the two ends into a tight seal against a synthetic rubber gasket, forming a leakproof fit.

The lengths of hoses vary but, in general, the discharge hose is of a 4 or 6-inch diameter, and comes in 50-foot lengths. The suction hose, in most cases, is 25 feet long, due to the excessive weight and stiffness of the reinforced wire plus its inability to be coiled for compact handling. A 2-inch discharge hose is available in 25-foot lengths.



A

A

1. Hose, suction, 2 IN.
2. Hose, discharge, 2 IN.
3. Quick disconnect coupler half, (female), 2 IN.
4. Hose, suction, 4 IN.
5. Hose, discharge, 4 IN.
6. Quick disconnect coupler, half (female), 4 IN.

B

B

1. Stainless steel banding
2. Quick-disconnect coupler half (female), 4 IN.
3. Quick-disconnect adapter half (male), 4 IN.
4. Cam arm ring
5. Cam arm

C

C

1. Stainless steel banding
2. Quick disconnect coupler half (female), 6 IN.
3. Quick disconnect adapter half (male), 6 IN.
4. Cam arm ring
5. Cam arm

Fig 1-8. Discharge and suction hoses with couplings.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. A suction hose has four distinct weaknesses. What are these weaknesses?

   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________

2. A 4- and 6-inch discharge hose generally comes in _________ foot lengths, while a suction hose is usually _________ feet long.

   a. 25, 50
   b. 50, 100
   c. 50, 25
   d. 25, 25

3. In the event of high vacuum, the discharge hose will

   a. explode.
   b. bulge.
   c. collapse.
   d. crack.

4. The action that causes a tight seal between hoses is known as a(n)

   a. hose.
   b. fittings.
   c. cam.
   d. coupling.

Work Unit 1-6. THE 50-GPM FILTER-SEPARATOR

LIST TWO FUNCTIONS OF THE 50 GPM FILTER SEPARATOR.

IDENTIFY THE PURPOSE OF THE FUEL QUALITY MONITOR.

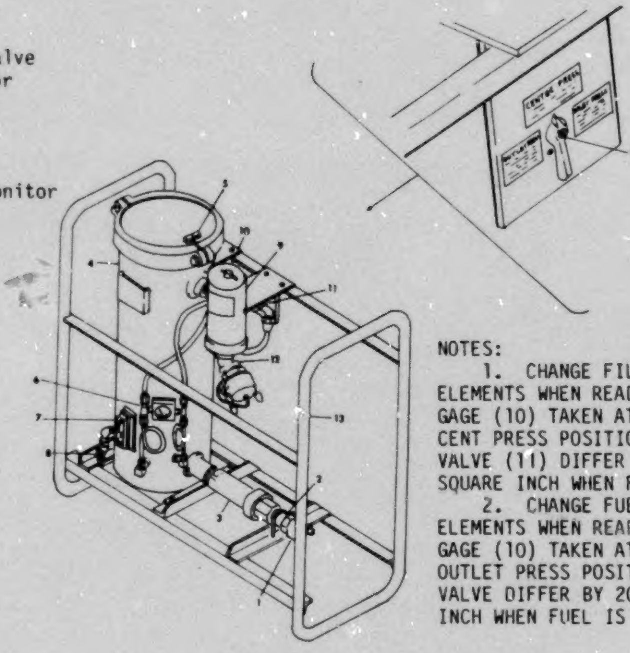
50-gpm Filter-Separator Assembly

This unit (fig 1-9) is a component of the Helicopter Expedient Refueling System (HERS). It is capable of handling 50 gallons per minute of the standard fuels. The filter-separator has four elements constructed of fiberglass which filter out the contaminants and perform a coalescing action (causing water in the fuel to form in large drops). The filter canisters have a teflon-coated screen which repels water that has formed into drops, while permitting the fuel to pass through. Mounted on the separator body are two pressure gages and a sight gage. The pressure gages indicate the inlet and outlet pressure and the sight gage indicates the amount of water in the separator. The elements must be replaced when the pressure differential reaches 20 psi or every two years.

Flow control valve (3, fig 1-9). This component, which is mounted on the inlet to the separator, limits the flow of fuel to 50 gallons per minute.

Fuel quality monitor (9, fig 1-9). The monitor is also mounted on the filter-separator assembly. Its function is to monitor the fuel, filter elements, and canisters. This unit will shut off the fuel flow when the water filtering capacity is exceeded.

1. Coupling
2. Nipple
3. Flow Control Valve
4. Filter-Separator
5. Air Eliminator
6. Gage
7. Sight Glass
8. Draincock
9. Fuel Quality Monitor
10. Pressure Gage
11. 3-Way Valve
12. Elbow
13. Base



NOTES:

1. CHANGE FILTER-SEPARATOR ELEMENTS WHEN READINGS ON PRESSURE GAGE (10) TAKEN AT INLET PRESS AND CENT PRESS POSITIONS OF THE 3-WAY VALVE (11) DIFFER BY 20 POUNDS PER SQUARE INCH WHEN FUEL IS FLOWING.
2. CHANGE FUEL QUALITY MONITOR ELEMENTS WHEN READINGS ON PRESSURE GAGE (10) TAKEN AT CENTER PRESS AND OUTLET PRESS POSITIONS OF THE 3-WAY VALVE DIFFER BY 20 POUNDS PER SQUARE INCH WHEN FUEL IS FLOWING.

Fig 1-9. 50-gpm filter-separator assembly.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The filter separator has four filter elements that perform two functions. What are these two functions?

   a. ____

   b. ____

2. The unit that shuts off the fuel flow when the water filtering capability is exceeded is called the

   a. flow control valve.
   b. fuel quality monitor.
   c. site gage.
   d. pressure gage.

Work Unit 1-7. THE 100-GPM FILTER-SEPARATOR

IDENTIFY TWO FUNCTIONS OF THE 100-GPM FILTER-SEPARATOR.

IDENTIFY THE MAXIMUM WORKING PRESSURE OF THE 100-GPM FILTER-SEPARATOR.

You have learned about the 50-gpm filter-separator, now try the 100-gpm filter-separator. As you look at this filter-separator (fig 1-10), you can see that there is a big difference in appearance between the two types. In the future, this filter-separator will become standard for the HERS instead of being used as an alternate.

The 100-GPM filter-separator was designed to filter and separate particles of contamination and water from light petroleum fuels. It is capable of handling fuels at a rate of 100 gallons per minute. This assembly is self-contained with a vertical type design. It has a removable cover, five replacement filter elements and canisters, a differential pressure indicator, and a water level sight gage. In addition, both a manual water drain and air vent are provided to ensure cleanliness of the fuel and efficient operation. The inlet and outlet valves are equipped with the cam lock fittings for quick disconnects. (Figure 1-11 shows a breakdown of these and other components and assemblies.) This filter-separator has a maximum working pressure of 75 psi and the unit weighs 100 pounds (dry weight).

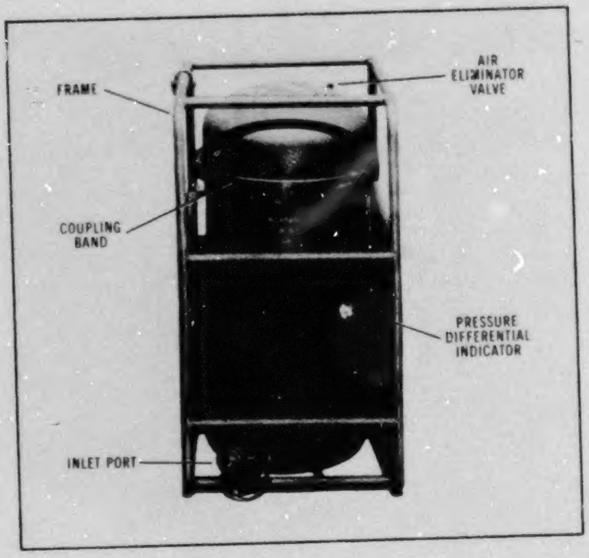
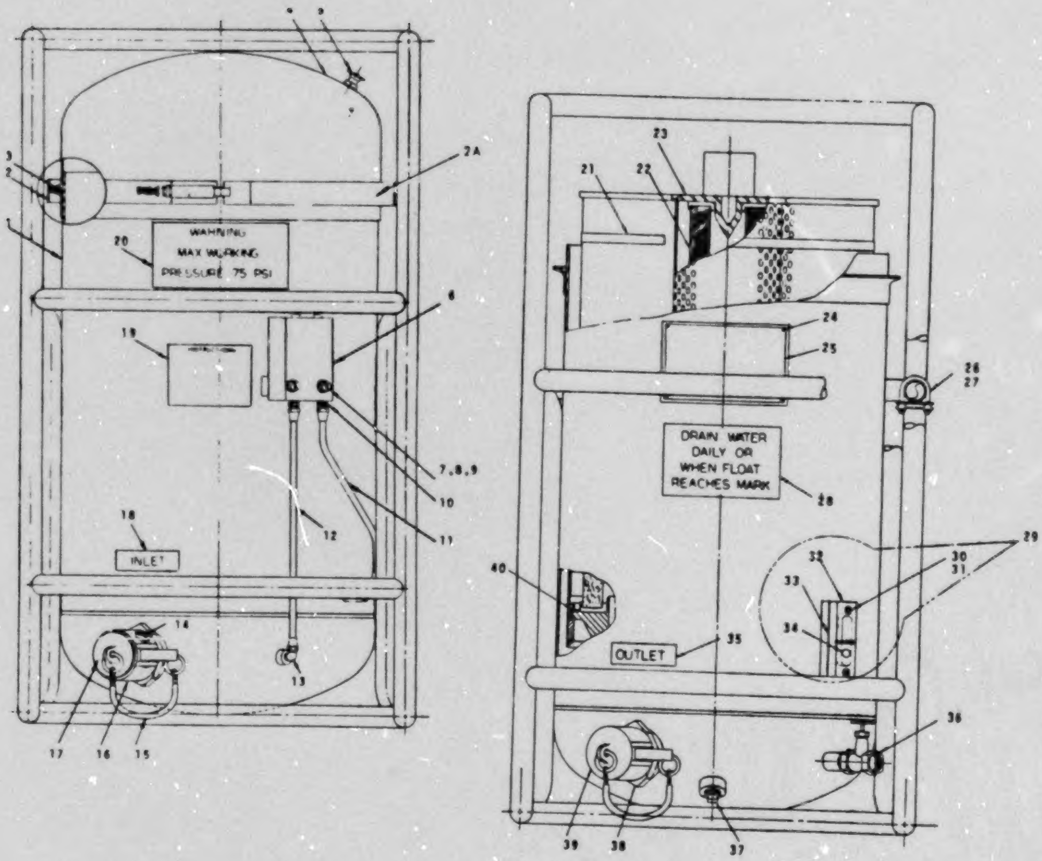

AIR ELIMINATOR VALVE
FRAME
COUPLING BAND
PRESSURE DIFFERENTIAL INDICATOR
INLET PORT

Fig 1-10. The 100-gpm filter-separator.


4
5
2A
3
2
1
20
WARNING MAX WORKING PRESSURE 75 PSI
6
19
7,8,9
10
12
11
18
INLET
14
13
17
16
15
23
21
22
24
25
26
27
DRAIN WATER DAILY OR WHEN FLOAT REACHES MARK
28
29
30
31
32
33
34
40
OUTLET
35
36
39
38
37

1. Tank and frame assembly
2. Clamp, cover
2A. Coupler, "V" retainer
3. Gasket, cover
4. Cover assembly
5. Valve, air vent
6. Differential pressure indicator
7. Screw, machine
8. Washer, flat
9. Washer, lock
10. Connector, male
11. Tube assembly
12. Tube assembly
13. Elbow, male
14. Gasket
15. Chain, security
16. Coupler
17. Plug, dust
18. Plate, data
19. Plate, data
20. Plate, data
21. Clamp, canister band
22. Element
23. Canister assembly
24. Screw, drive
25. Plate, identification
26. Clamp, grounding
27. Ground rod assembly
28. Plate, data
29. Sight gage assembly
30. Screw, machine
31. Washer, flat
32. Body, sight gage
33. Gasket, sight gage
34. Ball, float
35. Plate, data
36. Valve, water drain
37. Plug, pipe
38. Adapter
39. Cap, dust
40. Washer, spring tension

Fig 1-11. Components of the filter-separator.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The 100-gpm filter-separator is designed to filter and separate particles of _________ and _________ from light fuels.

a. oil, dirt
b. water, air
c. contamination, water
d. contamination, oil

2. What is the maximum working pressure of the 100-GPM filter separator?

a. 50 psi	c. 125 psi
b. 35 psi	d. 75 psi

Work Unit 1-8. THE 350-GPM FILTER-SEPARATOR

IDENTIFY THE TWO STAGES OF THE 350-GPM FILTER SEPARATOR.

The 350-GPM Filter-Separator is the piece of equipment in the tank farm that you can expect to use to filter out solids and undissolved water from light petroleum products. This assembly (fig 1-12) is a self-contained, skid-mounted unit, which is of a vertical-type design and aluminum construction. Basically, the filter-separator is a two-stage unit. The first stage consists of coalescing (intermingling, blending) filtering; fuel containing dirt and water enters the inlet and passes through the filters. Essentially, all solids are removed and all emulsions (heavy liquids) are broken (coalesced), thereby forming large water droplets which settle to the water accumulation sump for draining. The second stage consists of the external layer of the filter which contains chemically treated plasticized cellulose which blocks the passage of any water droplets and provides a second filtration barrier. The sump, where the water which has been separated from the fuel accumulates, is located on the bottom of the tank. A float assembly inside the sump is designed to float on water and to sink in fuel. The movement of the float assembly controls two diaphragm-actuated valves which operate the fuel discharge valve and the water drain valve. When the water level inside the unit approaches the maximum safe level, the water drain valve is opened to discharge the water. When excessive quantities of water enter the unit, causing the water to rise above the safe level, the fuel discharge valve is closed until the drain valve is able to eliminate the excess water. The bottom of the sump is designed to act as a vortex breaker to eliminate any whirlpool effect which would draw fuel into the water which is being discharged. A flow control is located in the fuel discharge valve to prevent the flow of fuel from exceeding the rated flow. Quick-disconnect couplings are provided on the inlet and discharge fittings. A selector control and pressure gage are mounted on the unit to obtain pressure readings of the inlet and discharge sides in order to determine the pressure drop across the filter-separator.

Fig 1-12. The 350-GPM Filter-Separator.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The first stage of filtering in the 350-GPM Filter-Separator consists of

   a. a filter element.
   b. a sump.
   c. coalescing.
   d. plasticized cellulose.

2. The second stage of filtering in the 350-GPM Filter-Separator consists of

   a. filter elements.
   b. intermingling.
   c. blending.
   d. coalescing.

Work Unit 1-9. THE FUEL MONITOR

IDENTIFY THE PURPOSE OF THE GO-NO-GO GAGE.

IDENTIFY THE CORRECTIVE ACTIONS FOR THE GO-NO-GO GAGE WHEN THE FUEL FLOW SHUTS DOWN.

The fuel monitor assembly (fig 1-13), referred to as a GO-NO-GO gage, is installed downstream of the filter-separator in the fuel system. Its purpose is to remove both solid contaminants and undissolved water from the fuel being handled and, more importantly, to act as a fuel cleanliness monitor. If solid contaminants or water exceed a safe level, filter elements (referred to as fuses) will shut off all flow. When this occurs, it indicates that filters or water separators upstream are not performing properly. The trouble must be located and corrected, and the GO-NO-GO fuses must be replaced before continuing the operation.

The GO-NO-GO gage is mounted horizontally on a roll-over aluminum skid frame. Quick-disconnect hose couplings are provided for the inlet and outlet connections. A pressure gage and 3-way plug are provided to monitor either the inlet or outlet pressure. A ground rod and separate ground lead assembly are provided for grounding the skid frame during operation. Steel tiedown or towing eyes are provided at the four corners of the skid. Two aluminum lifting eyes are welded to the top of the roll-over frame.

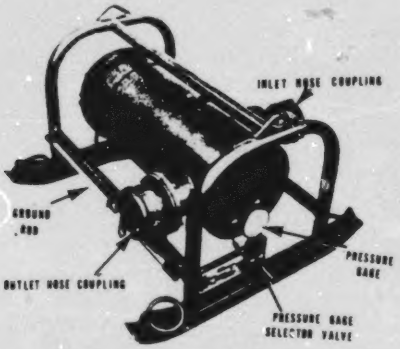


Fig 1-13. Fuel monitor assembly.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The purpose of the GO-NO-GO gage is to remove solids and water, but more importantly to act as a

   a. filter-separator.
   b. manifold.
   c. fuel cleanliness monitor.
   d. hose coupling.

2. When the GO-NO-GO gage shuts down the fuel flow, the ______________ is not operating properly.

   a. filter-separator
   b. manifold
   c. fuel cleanliness monitor
   d. hose coupling

3. When fuel flow problems are corrected, the GO-NO-GO gage ______________ must be changed.

   a. cartridges
   b. canisters
   c. fuses
   d. tanks

Work Unit 1-10. THE FUEL METER/REGISTERS

IDENTIFY THE FLOW RATE CAPABILITY OF THE FUEL METER/REGISTER.

IDENTIFY TWO FUNCTIONS OF THE FUEL METER/REGISTER.

The purpose of the meter assembly is to register and show you how much fuel, in gallons, is dispensed and received. A visible register, located on top of the meter, records fuel being dispensed at each individual operation as well as keeping a cumulative total of all fuel issued or received.

The 3-inch meter/register assembly, equipped with 4-inch coupler and adapter, (fig 1-14) is a lightweight, portable, skid-mounted unit consisting of a meter, visible register, grounding rod, wire and clip assembly for grounding, and two quick-disconnect coupling-halves for connecting hoses. The meter consists of a short section of pipe with a chamber that houses a rotor capable of metering fluids at flow rates between 50 gpm and 650 gpm at a maximum pressure of 200 psi. The meter is factory-tested and factory-calibrated before shipment and can be readily field-adjustable with no special tools. There are no close clearances with the meter body, thereby eliminating the need for strainers. The rotor, powered by flow, uses a permanent magnet and coupling to drive the externally mounted mechanical register. The inlet and outlet connections of the meter are threaded and equipped with quick-disconnect coupling-halves. The base of the meter is bolted to the frame.

Note: HERS requires two 2-inch meter assemblies. They are connected downstream of the fuel monitor and can record 99999 gallons. AAFS has two 3-inch and six 2-inch meter assemblies.

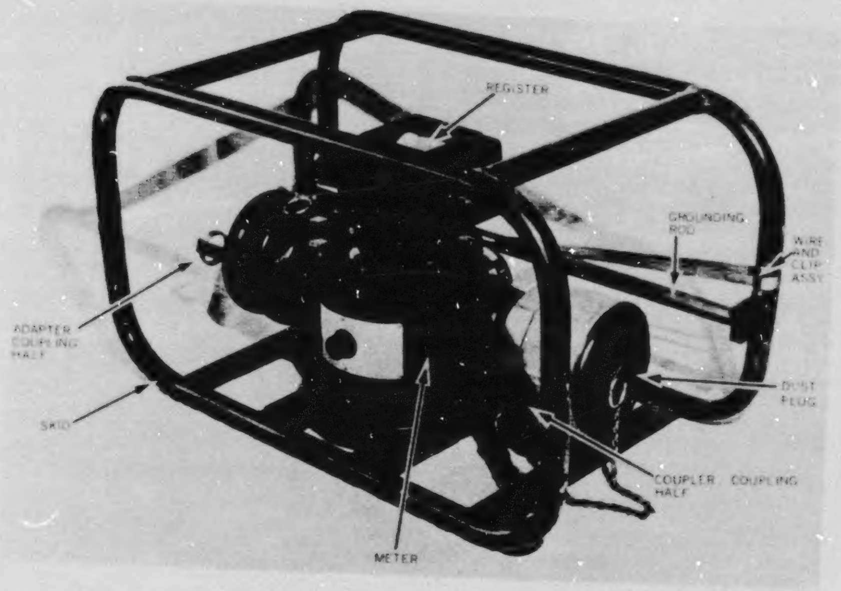

REGISTER
GROUNDING ROD
WIRE AND CLIP ASSY
ADAPTER COUPLING HALF
DUST PLUG
SKID
COUPLER COUPLING HALF
METER

Fig 1-14. Three-inch meter register assembly.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The flow rate capability of the meter/register assembly ranges between 50 gpm and __________ gpm.

   a. 100
   b. 350
   c. 600
   d. 650

2. The purpose of the meter/register assembly is to register and show how much fuel is

   a. dispensed in gallons.
   b. received in gallons.
   c. dispensed and received in gallons.
   d. missing in gallons.

3. The 2-inch meter assembly can record up to _____________ gallons.

   a. 999
   b. 9999
   c. 99999
   d. 999999

Work Unit 1-11. THE PRESSURE REGULATOR

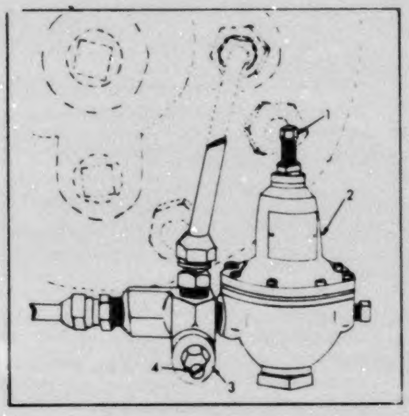
IDENTIFY ONE PURPOSE OF THE PRESSURE REGULATOR.

IDENTIFY THE ADJUSTMENT RANGE OF THE PRESSURE REGULATOR.

The pressure regulator (Fig. 1-15) assembly is essentially a diaphragm-activated hydraulic regulating valve equipped with suitable quick-disconnect fittings so that it may be readily installed in the AAFS. Its primary purpose is to limit line pressure on the downhill grades.

Internal fuel pressure is controlled by the pressure regulator valve, which, in turn, is governed by the adjustment of the reducing valve located on top and toward the discharge end of the regulator assembly. The reducing valve is designed to provide sensitive control of the pressure regulating valve in order to insure accurate regulation of the fuel discharge pressure. The reducing valve is adjustable within a range of 30 to 110 psi. A flow control valve, which is connected to and works in conjunction with the reducing valve, controls the rate of pressure flow to and from the top of the pressure regulating valve diaphragm in order to provide a balanced opening or closing of the valve. The selector control, which is a 3-way valve located in the tubing below the pressure gage, enables the operator to obtain readings of the inlet and discharge pressures of the pressure regulating assembly.

Fig 1-15. Six-inch pressure regulator (front-view).



1. Adjusting screw
2. Reducing control
3. Flow control valve
4. Adjusting screw

Fig 1-16. Six-inch regulator assembly Flow control valve

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The primary purpose of the pressure regulator is to limit line pressures on

   a. flat lands.
   b. uphill grades.
   c. downhill grades.
   d. underwater areas.

2. The item of equipment that is adjustable within a range of 30 to 110 psi is the

   a. discharge valve.
   b. reducing valve.
   c. 3-way valve.
   d. gate valve.

Work Unit 1-12. THE FUEL MANIFOLD

GIVEN FOUR MANIFOLD ASSEMBLIES AND THE CHARACTERISTICS FOR EACH, MATCH EACH MANIFOLD ASSEMBLY WITH ITS CHARACTERISTIC.

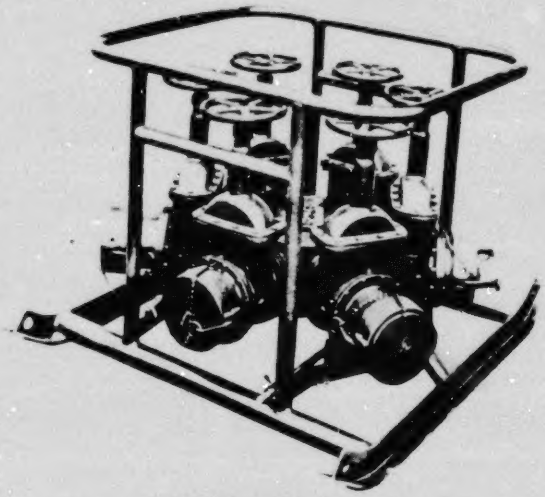
The skid-mounted manifold assembly is a crossroad for the transfer lines through which the product is received from the booster station and channeled to the tank farms. It is also used to channel fuel within the tank farm.

Six-inch manifold (11). This manifold is equipped with six gate valves and is used primarily in the distribution and supply of fuel to the tank farms.

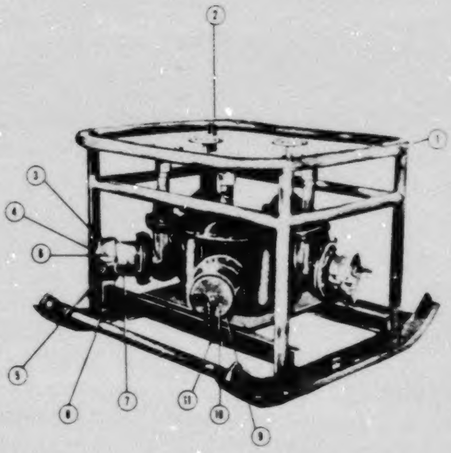
Four-inch manifolds. There are two 4-inch manifolds, one is equipped with six gate valves (12) and the other is equipped with five gate valves (13). Each manifold is central to each tank farm and is used to distribute fuel to the tanks and the dispensing stations. Both the 6-inch and 4-inch sizes are equipped with quick disconnect adapters and couplers plus dust plugs and caps.

Drum unloading manifold (14). This manifold connects the 2-inch suction lines to the drums and the 4-inch suction line to the pump.

Fuel-dispensing manifold (15). This manifold connects the 4-inch discharge hose to the 2-inch dispensing hoses.

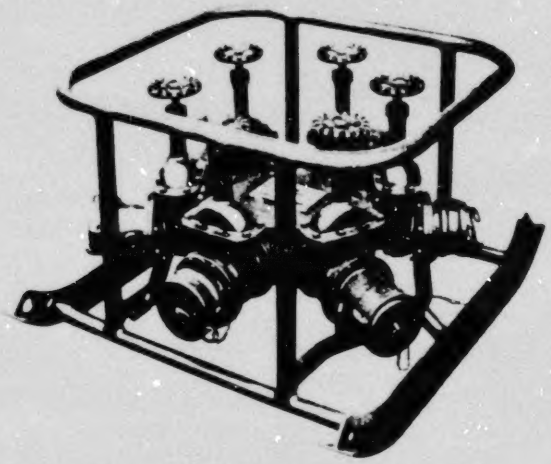


11 Manifold assembly 6-in.

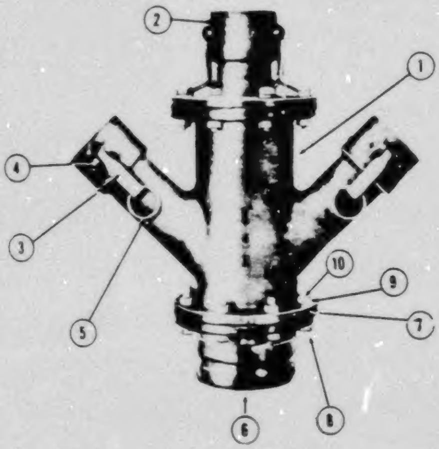


1. Skid Assembly
2. Valve Gate
3. Adapter Assembly
4. Cap
5. Cam Lever
6. Rivet
7. Ring
8. Chain
9. Coupler Assembly
10. Plug
11. Chain

13 Manifold assembly 4-in.

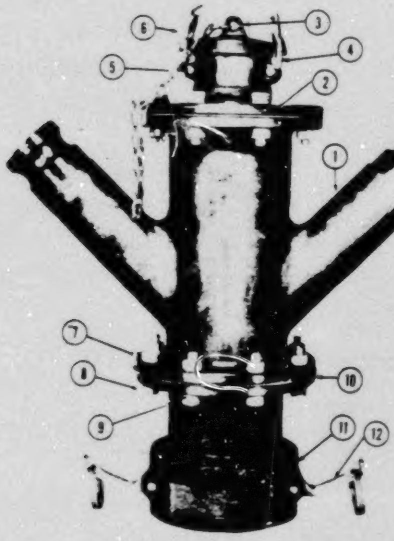


12 Manifold assembly 4-in.



1. Manifold
2. Coupler
3. Cam Lever
4. Rivet
5. Ring
6. Adapter
7. Gasket
8. Bolt
9. Washer
10. Nut

14 Manifold drum unloading



1. Reducer
2. Reducer
3. Cap
4. Cam Lever
5. Rivet
6. Ring
7. Nut
8. Bolt
9. Washer
10. Gasket
11. Coupler Assembly
12. Arm

15 Manifold, fuel dispensing

Fig 1-17. Manifold assemblies.

Fittings and manifolds. All fittings and manifolds in the system can be connected together either directly or with an adapter. Figure 1-17 shows various types of fittings and manifolds issued with the system. The wide variety of fittings and manifolds makes the system adaptable to practically all types of situations and terrain.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

Matching: Column 1 (items 1-4) lists four manifold assemblies. Column 2 (a through d) lists identifying characteristics of each of the four manifold assemblies. Match each manifold assembly in column 1 with its identifying characteristic in column 2. Place your answers in the spaces provided.

	Column 1 Manifold assembly	Column 2 Characteristic
____	1. 4-inch manifold	a. 5 or 6 gate valves
____	2. 6-inch manifold	b. 6 gate valves
____	3. Drum unloading manifold	c. 2-inch suction lines
____	4. Fuel dispensing manifold	d. 2-inch dispensing hose

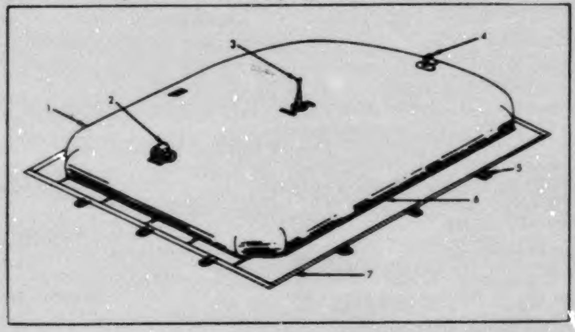
Work Unit 1-13. THE 20,000 GALLON COLLAPSIBLE TANK

DEFINE THE "FLOATABLE ROOF" PRINCIPLE.

STATE THE THREE MAIN PHYSICAL FEATURES OF THE 20,000 GALLON COLLAPSIBLE TANK.

The 20,000 gallon tank (fig 1-18) is designed for storage of liquid fuels in military operations. Safety was also considered in the design of these tanks. When the tank has fuel in it, the top of the tank always comes in contact with the fuel. This is called the "floating roof" principle as it minimizes the air space where fumes accumulate, thereby making it safer. Collapsible tanks also cause less contamination than the metal rigid type. They are comparatively light in weight and, when not in use, they are placed in tank chests for compact storage and easy handling.

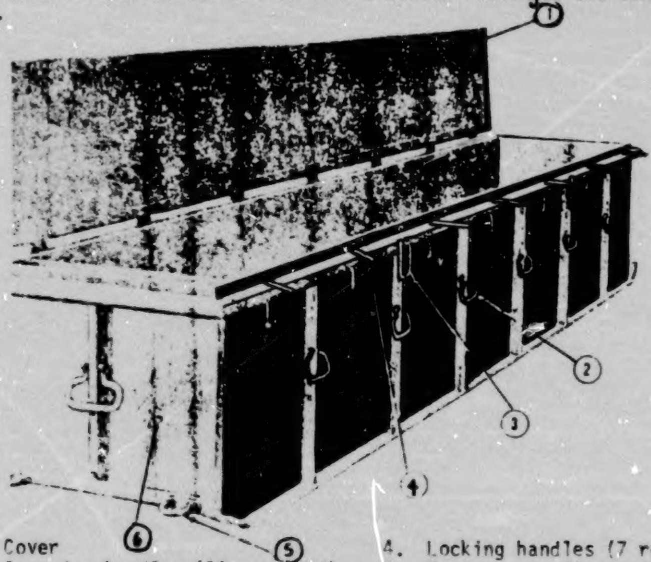
This high-capacity tank is used in both systems (AAFS or TAFDS). It is constructed of square-woven fabric impregnated with petroleum-resistant material and can be folded compactly for storage in the limited space of a tank chest. Coated fabric hand straps are provided along the sides of the tank for moving and positioning before filling. This 20,000-gallon tank, when filled, assumes somewhat of an elliptical shape approximately 23 feet wide, 5 feet 9 inches high, and 25 feet long. The tank (1, fig 1-18) is equipped with one inlet (4, fig 1-18), one outlet fitting (2, fig 1-18), and one vent fitting (3, fig 1-18). To permit inspecting, cleaning, and repairing of the tank, an oval closure plate is provided near the end of the tank. The vent fitting is equipped with a relief valve to permit venting of fumes during warm weather loading and unloading operations.



1 Tank
2 Discharge fitting
3 Flame-arrestor vent
4 Inlet fittings
5 Ground cloth hand straps
6 Tank hand straps
7 Ground cloth

Fig 1-18. Collapsible 20,000-gallon tank.

a. Tank chest (fig 1-19). The tank chest is the container that is also provided with all 20,000-gallon-capacity collapsible tanks. It is constructed of lightweight aluminum and it is equipped with cover (1); carrying handles (2) for manhandling; lifting hooks;(3) for hoisting with a lifting device; and towing eyes (5) for movement by means of towing. One end of the chest is partitioned to accommodate the inlet and outlet fittings, the vent assembly, and the tank repair kit.



1. Cover
2. Carrying handles (14 required)
3. Lifting hooks (4 required)
4. Locking handles (7 required)
5. Towing eyes (4 required)
6. Tank chest body

Fig 1-19. Tank chest.

b. Ground cloth. A ground cloth is provided with each collapsible tank. The size of the cloth depends on the size and capacity of the collapsible tank. Its purpose is to protect the tank. The ground cloth is a sheet made from rubberized nylon with eight coated fabric hand straps provided for moving and positioning. After the berm has been prepared and inspected for stones, sharp obstacles, etc., the ground cloth is positioned in the berm to conform with the dimensions of the tank. It acts as a bed for the tank, thus affording further protection.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. Define the floating roof principle.

____

____

2. What are the three major physical features of the 20,000 gallon tank?

a. ______________________________________
b. ______________________________________
c. ______________________________________

Work Unit 1-14. THE 500-GALLON DRUM

IDENTIFY THE QUANTITY OF 500-GALLON DRUMS USED IN THE HERS.

IDENTIFY ONE ELBOW COUPLER VALVE CHARACTERISTIC.

The 500-gallon drum (fig 1-20) is a durable nonvented collapsible container. When filled, the drum assumes a cylindrical shape and is approximately 6 feet 8 inches and 3 feet 10 inches in diameter. The drum is constructed of fabric impregnated with fuel-resistant synthetic rubber. The body is equipped with a closure plate (fig 1-21) on each end. Each closure plate is equipped with a swivel ring and two anchor shackles. The shackles are for the attachment of lifting slings, for attachment to parachutes, or for use in towing the container short distances. The drum must not run over sharp objects or rough terrain. Filled drums can be transported as air cargo or by helicopter as an external load. The drums, however, will not survive a free-fall air drop as they will burst on impact. The front closure plate is also equipped with a check valve adapter and elbow coupler valve with a dust cap. You must remember that this valve opens and closes just the opposite of most other valves. The valve opens with a clockwise motion and closes with a counterclockwise motion. When collapsed, the drum can be folded to permit transportation. This type drum is the main storage component for the HERS which has eighteen of them.

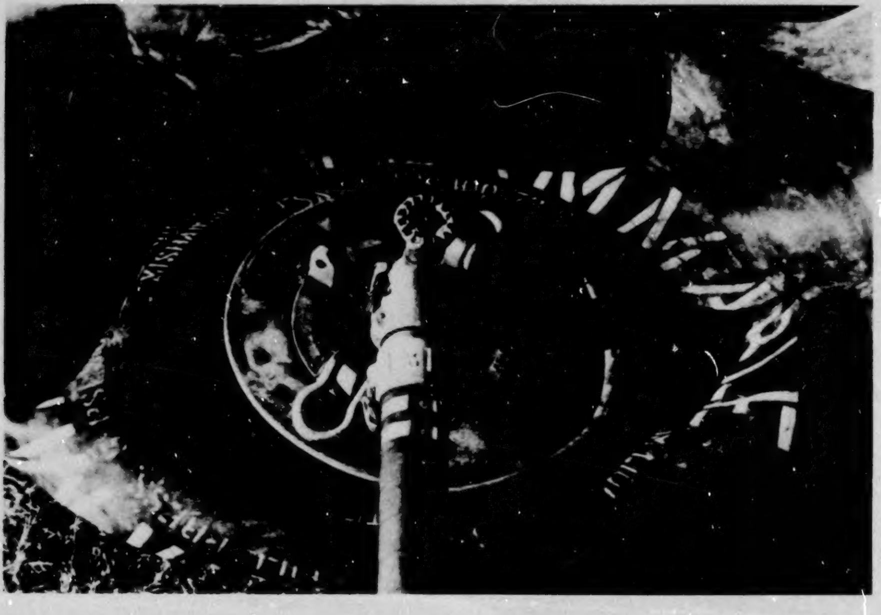
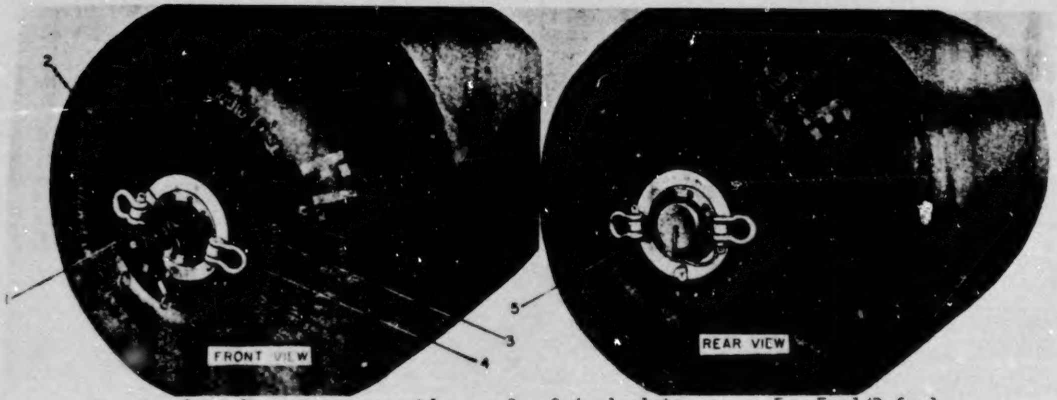


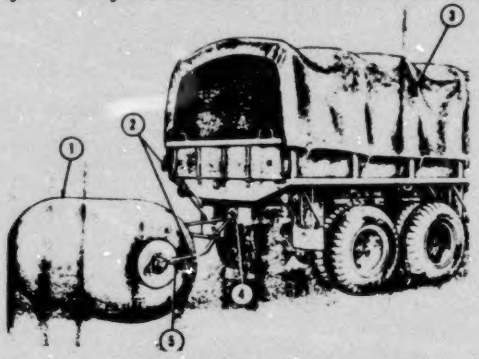
Fig 1-20. The 500-gallon drum.



1. Coupler elbow valve assembly
2. Check valve assembly adapter
3. Swivel plate
4. Shackle
5. Fuel/Defuel valve assembly

Fig 1-21. Drum, fabric, collapsible, liquid fuel, 500-gallon-capacity (nonvented).

To facilitate the use of the drum, a collapsible yoke (fig 1-22) provides a means for towing the drum short distances and for lifting with power equipment or by helicopter. The yoke is constructed of two sections of tubular steel with each section having an upper leg, connecting leg, and brace. When assembled, the two sections connect at the braces, the upper legs forming an eye. The yoke attaches to a shackle on each end of the drum.



1. 500-gallon drum
2. Yoke
3. Cargo Truck
4. Pintle
5. Clevis

Fig 1-22. The 500-gallon drum with yoke attached to cargo vehicle.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The HERS contains ________ 500-gallon fuel drums.

a. 6
b. 12
c. 15
d. 18

2. Unlike most gate valves, to close the elbow coupler valve you should

a. turn it clockwise.
b. turn it counterclockwise.
c. push.
d. pull.

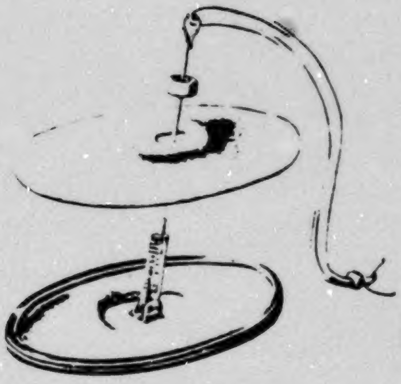
Work Unit 1-15. EMERGENCY REPAIR KIT/GENERAL REPAIR KIT

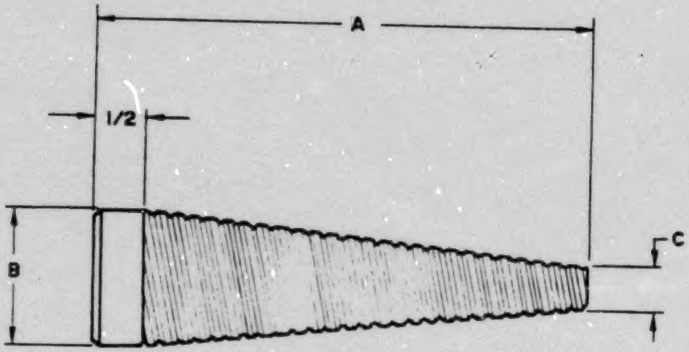
IDENTIFY ONE CHARACTERISTIC OF THE EMERGENCY REPAIR KIT.

IDENTIFY ONE CHARACTERISTIC OF THE GENERAL REPAIR KIT.

When you work with fuel drums and collapsible tanks, leaks and seepage are inevitable. Hence, repair kits have been developed to make quick and efficient repairs.

Emergency repair kit. An emergency repair kit is furnished with each collapsible tank and is stored in the partitioned end of the tank chest. The kit includes mechanical repair patches (fig 1-23a) and gaskets necessary for emergency tank repairs. New procurement tanks will have threaded tapered wood plugs (fig 1-23b), in three and five inch sizes. The two wooden plugs vary in diameter with the three inch size having a one-quarter inch diameter, while the five inch size has a one-half inch diameter.





SIZE	A	B	C
3 INCH	3	3/4 DIA.	1/4 DIA.
5 INCH	5	1-1/2 DIA.	1/2 DIA.

DIMENSIONS IN INCHES

Fig 1-23(a). Mechanical Repair Patch. Fig 1-23(b). Threaded tapered wood plug.

General repair kit (fig 1-24). This kit consists of spare parts, gaskets, packing, and a limited number of tools for the routine maintenance, replacement, and repair of individual items in the system. It also includes evacuation kits for 4- and 6-inch hoses, and a combustible gas indicator for detecting hazardous vapor accumulation. Hose clamps (4- and 6-inch sizes) (fig 1-25) are also contained in this kit. All items are stored in three lightweight, aluminum chests which comprise part of the kit.

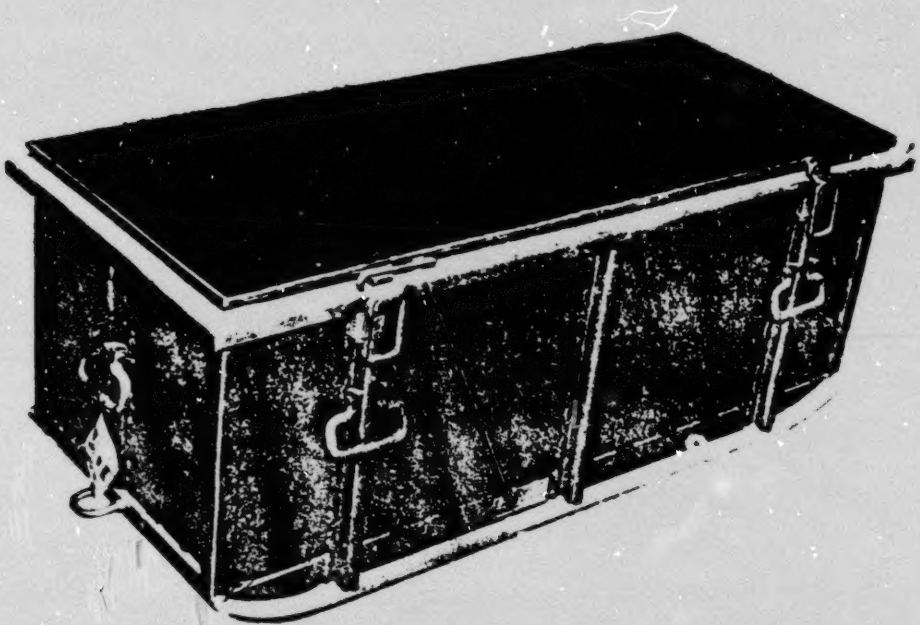


Fig 1-24. General repair kit chest.

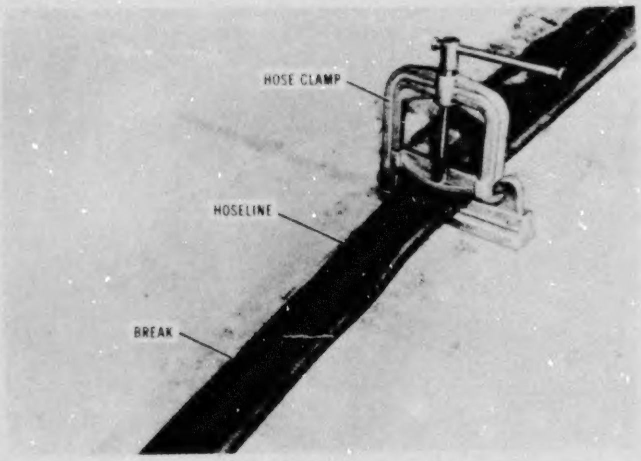

HOSE CLAMP
HOSELINE
BREAK

Fig 1-25. Hose repair clamp.

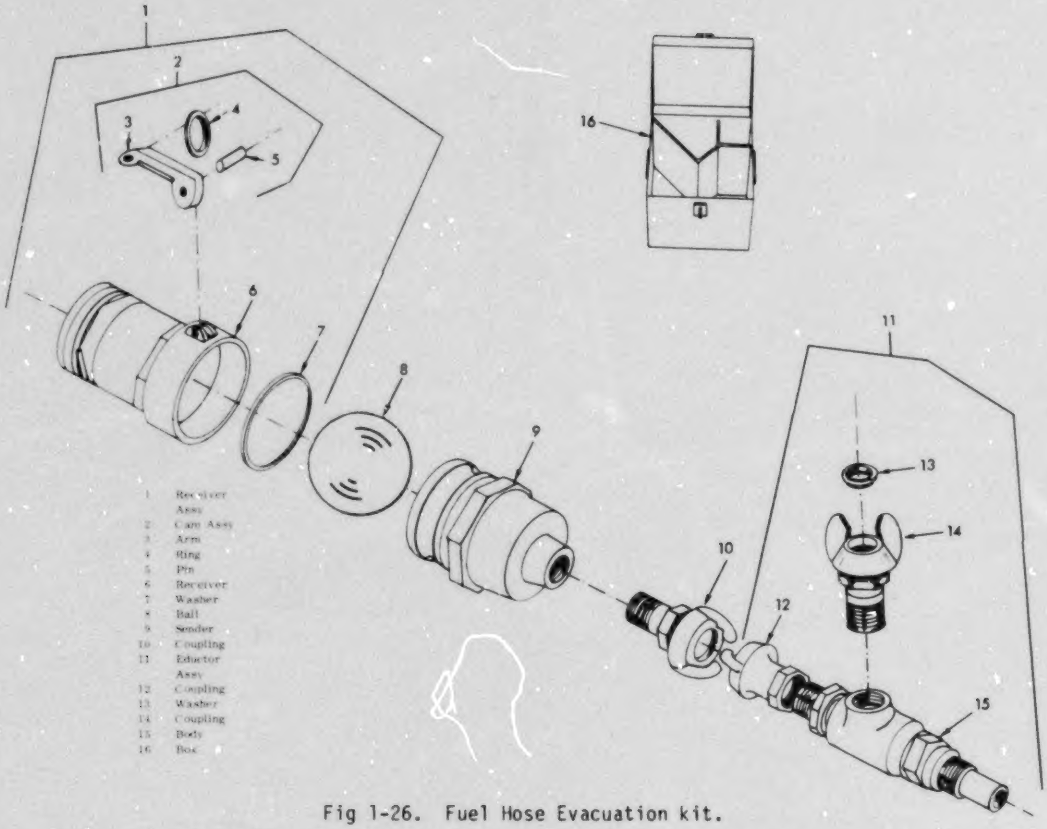

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
1 Receiver Assy
2 Cam Assy
3 Arm
4 Ring
5 Pin
6 Receiver
7 Washer
8 Ball
9 Sender
10 Coupling
11 Eductor Assy
12 Coupling
13 Washer
14 Coupling
15 Body
16 Box

Fig 1-26. Fuel Hose Evacuation kit.

Fuel hose evacuation kit (fig 1-26). This kit is connected to an air compressor and is used to purge hose lines to clear them of fuel. The ball should be well lubricated with GAA to allow it to pass through all hose connections.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The emergency repair kit is furnished with patches, gaskets and

   a. bolts.
   b. adapters.
   c. clamps.
   d. plugs.

2. The general repair kit includes evacuation kits for _________ and _________ hoses.

   a. 2-inch, 4-inch
   b. 4-inch, 6-inch
   c. discharge, 4-inch
   d. discharge, 6-inch

Work Unit 1-16. BULK FUEL HARDWARE

IDENTIFY TWO TYPES OF FUEL-SERVICING NOZZLES.

STATE THE PURPOSE OF THE LIQUID SIGHT INDICATOR.

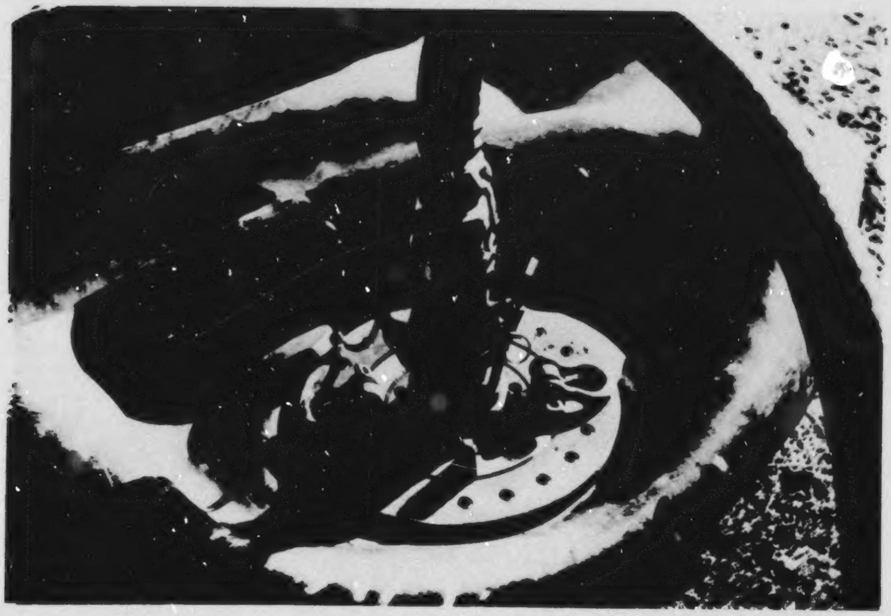
STATE THE PURPOSE OF THE STRAINER ASSEMBLY.

STATE THE PURPOSE OF THE WYE COUPLINGS.

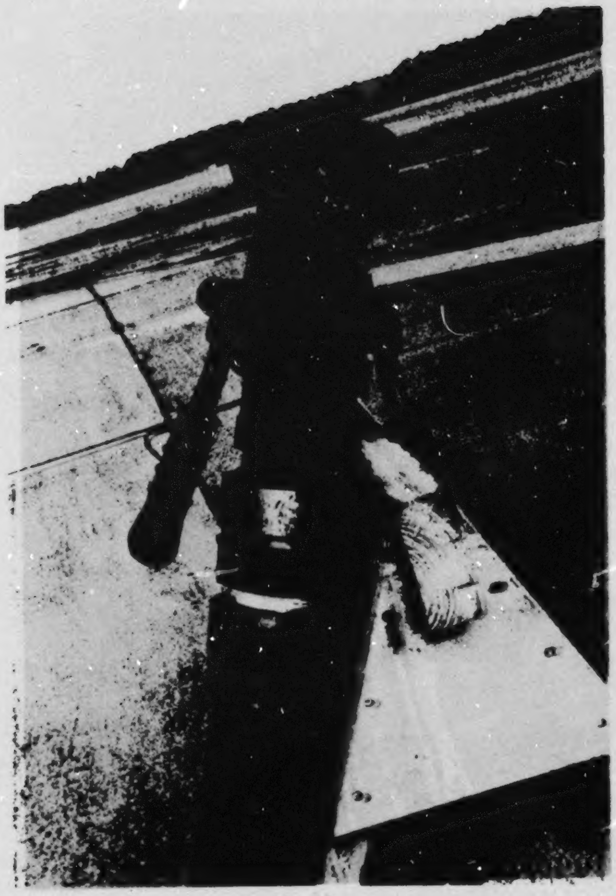
This work unit will cover nearly all of the nozzles, gate valves, and other miscellaneous bulk fuel hardware. However, miscellaneous should not be taken to mean trivial as each piece of hardware has an important function.

a. Fuel-servicing nozzles. There are two types of fuel-servicing nozzles that you must be concerned with (fig 1-27).

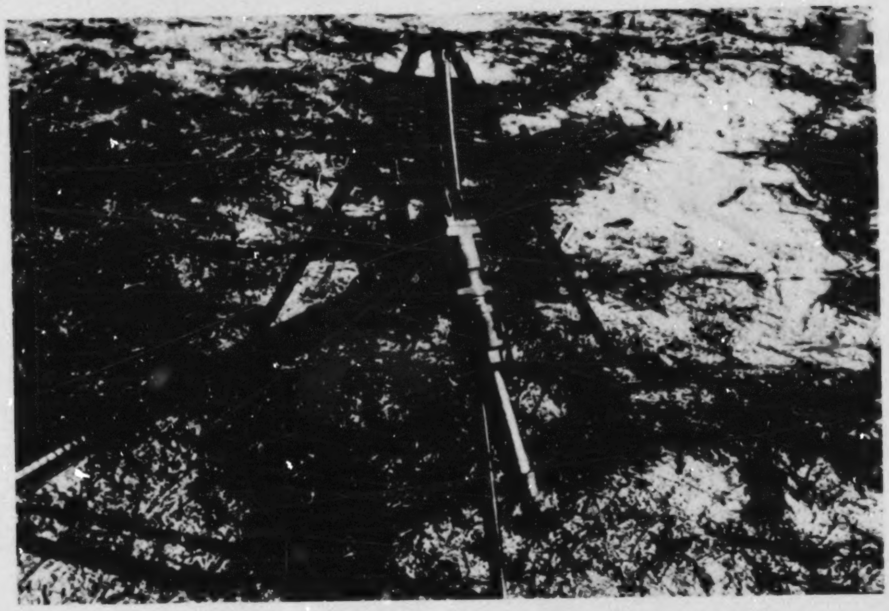
(1) Pressure type. The 2-inch pressure locking nozzle (1) is primarily intended for use in fueling or defueling various items of ground equipment such as the 500-gallon collapsible drum; it may also be used for fueling helicopters. The 4-inch pressure locking nozzle (2) is used in defueling. These nozzles are furnished with a positive shutoff device in order to prevent fuel and vapors from escaping when an aircraft is being refueled with its engines in operation.



1. Pressure Locking Nozzle, 2-Inches



2. Pressure locking nozzle, 4-inches



3. Fuel-servicing nozzle, 1 1/2-inches

Fig 1-27. Nozzles.

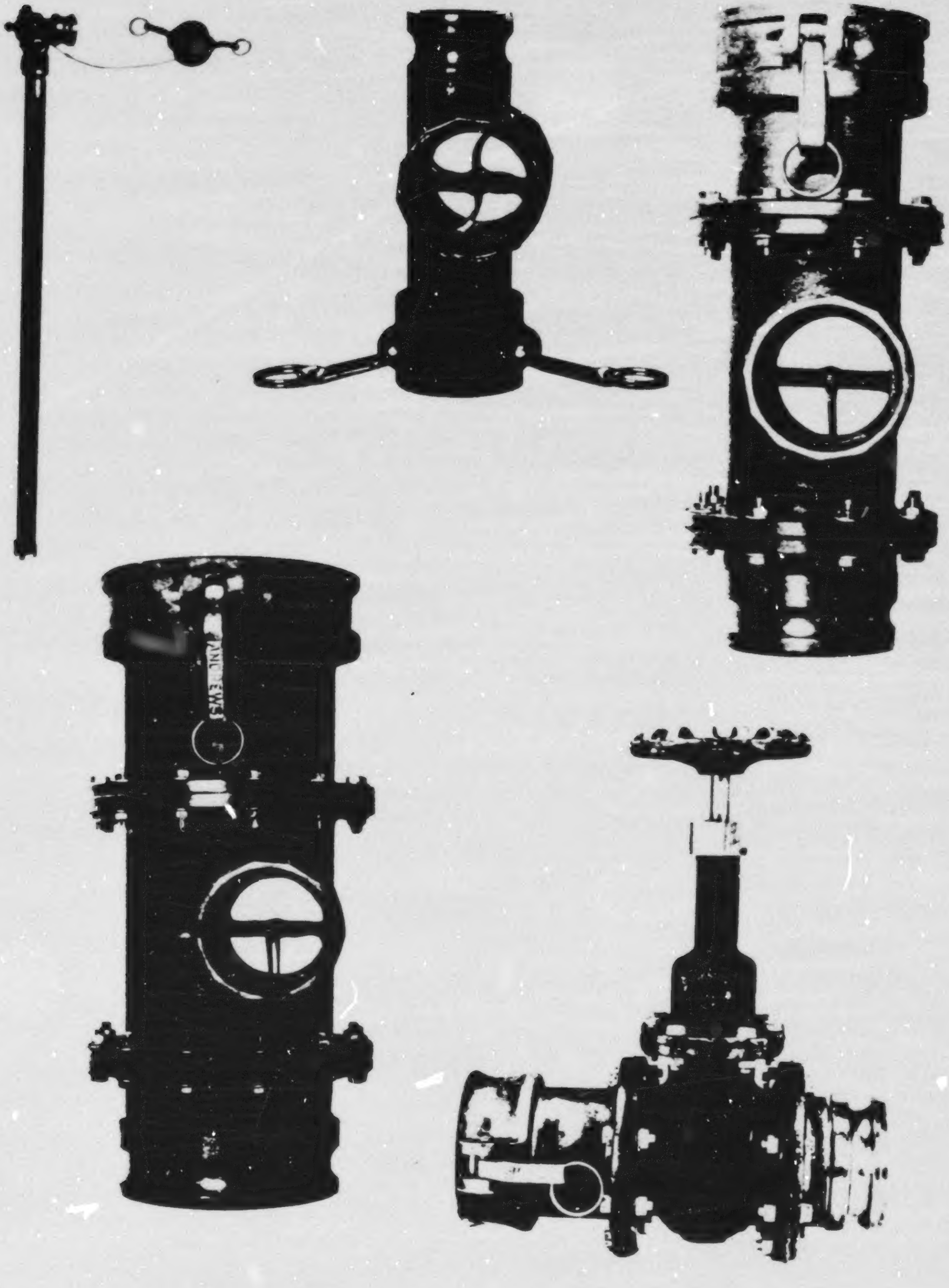
(2) Service station type or Gravity Fed. The fuel servicing nozzle (3, fig 1-27), sometimes referred to as the gravity type, comes in the 1 1/2-inch size. This nozzle is used in the dispensing stations for dispensing fuel to vehicles, drums and aircraft.

b. Hardware (fig 1-27b).

(1) Drum unloading valve. The drum unloading valve (or suction stub assembly) (4, fig 1-27b) is equipped with a 2-inch suction tube for unloading fuel from drums and cans.

(2) Liquid sight indicator. The liquid sight indicator, which comes in three sizes, 2-inch (5, fig 1-27b), 4-inch (6, fig 1-27b), and 6-inch (9), is used to indicate the fuel flow.

(3) Gate valve, 4-inch. The 4-inch gate valve (8, fig 1-27b) is equipped with flanges for connecting either to quick-disconnect adapters or couplers, flanges or other flanged connections. The valves are used throughout the system on the various components and in major hose connections.

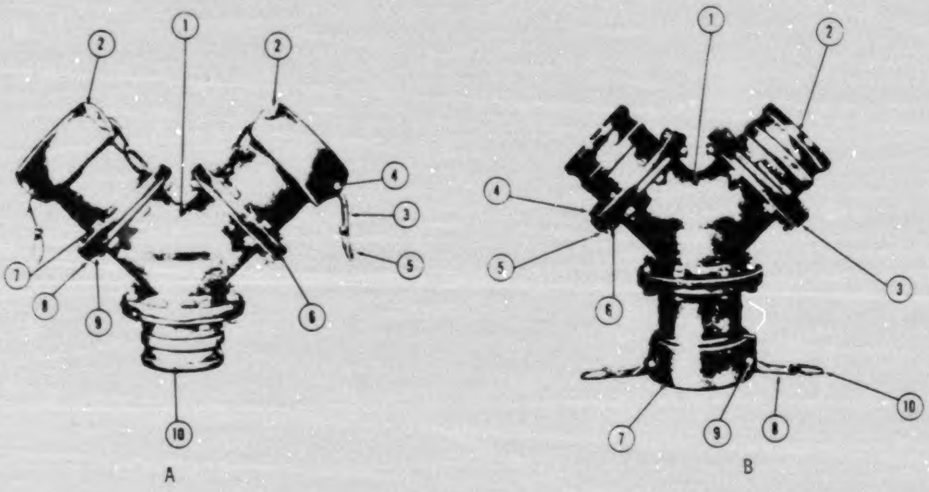


4. Drum unloading valve
5. Liquid sight indicator, 2-inches
6. Liquid sight indicator, 4-inches
7. Liquid sight indicator, 6-inches
8. Gate valve, 4-inches

Fig 1-27b. Liquid sight indicators and valves.

c. Wye couplings (fig 1-28). These couplings are used as facilitating connections between the suction and discharge hose transfer lines.

1.
2.
3.
4.
5.



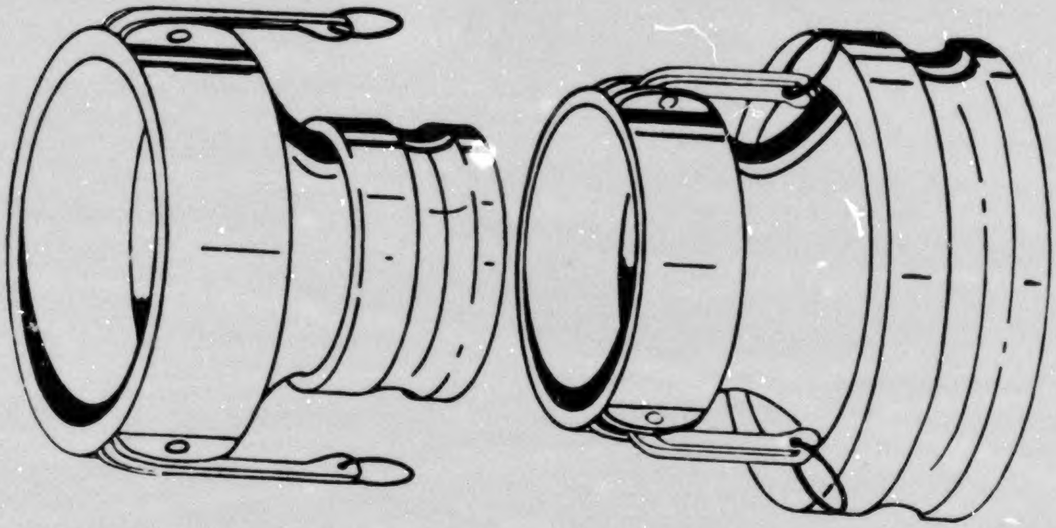
1. Wye Fitting
2. Coupler Assembly
3. Arm
4. Pin
5. Ring
6. Gasket
7. Bolt
8. Washer
9. Nut
10. Adapter Assembly

A Wye couplings, female
B Wye couplings, male

Fig 1-28. Couplings.

1. Wye Fitting
2. Adapter Assembly
3. Gasket
4. Bolt
5. Washer
6. Nut
7. Coupler Assembly
8. Arm
9. Pin
10. Ring

d. Reducer assemblies (fig 1-29). For convenience in interconnecting the 6-inch and 4-inch segments of the AFFS, the high-capacity system has four 6-inch Cx4-inch A reducer assemblies (A) and one 4-inch A reducer assembly (B).



A 6-in. Cx4-in. Adapter

B 4-in. Cx6-in. Adapter

Fig 1-29. Reducer assemblies.

e. Strainer assembly (fig 1-30). The 6-inch skid-mounted strainer assembly is part of the over-the-bench fuel supply equipment used when receiving fuel from vessels off shore. Its purpose is to remove any solid contaminants such as sand and rust that could be sucked up from the bottoms of the tanker.

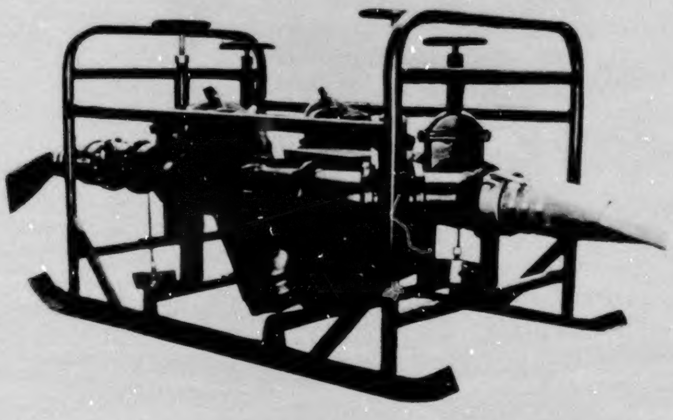


Fig 1-30. Strainer assembly.

f. Fuel adapter assembly. The fuel adapter assembly consists of individual items of hardware (most have already been covered in this study unit), which are interchangeable throughout the system. The purpose of this assembly of items is to allow "hook up" with, or to connect your system to other fuel systems regardless of the type of equipment used. Items which are part of the assembly that have not been mentioned consist of various elbows and flanges that help make connection to the fuel source. The pipe-to-hose adapter is the actual link to the fuel source. The 2-inch elbow (fig 1-31) is used for the small amphibious ship over-the-beach unloading operation. Properly secured, this elbow will prevent chafing and pinching during the shuttlecraft loading operation.

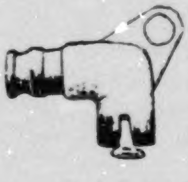


Fig 1-31. 2-inch elbow.

g. Fuel nozzle stand (fig 1-32). The fuel nozzle stand is used at dispensing points. Its purpose is to suspend the fuel nozzles to keep them off the ground and out of the dirt, mud, etc. Also leaks from the nozzle or connection can be detected quicker and easier.

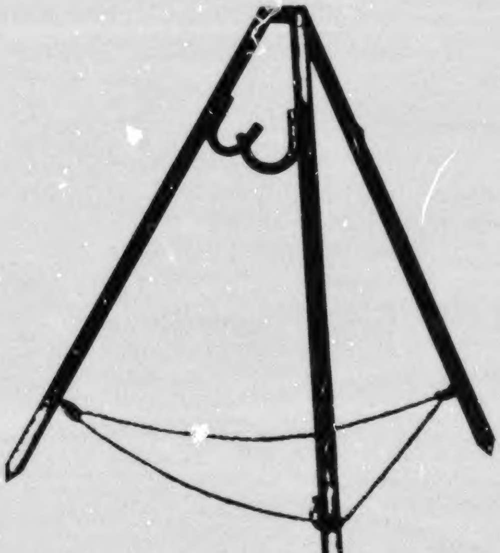
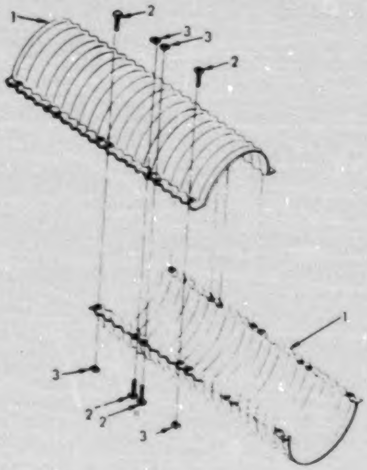


Fig 1-32. Fuel nozzle stand.

h. Conduit. The purpose of a conduit is mainly to protect the hose. It provides a tunnel under roads where traffic might damage it. Two types of conduits currently afford this protection. They are the:

(1) Small-pipe type. This conduit is 8 inches in diameter, comes in sections 10 feet long, and will accommodate hose up to 4 inches. It is not recommended for use with the 6-inch hose although it could be used.

(2) Nestable pipe culvert. This type of conduit is fabricated from 2-foot corrugated galvanized steel half-sections, each section 2 feet long. When assembled, this 2-foot-diameter culvert has some advantages over the smaller type. It can easily accommodate any size hose in the system, and it is more durable and versatile.



1 Culvert halves
2 Bolts
3 Nuts

Fig 1-33. Nestable pipe culvert.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The two types of fuel-servicing nozzles are:

a. ______________________________
b. ______________________________

2. What is the purpose of the liquid sight indicator? ______________________________

3. The purpose of the strainer assembly is ______________________________

4. The purpose of the wye couplings is ______________________________

SUMMARY REVIEW

Now that you have completed this study unit, you have learned the operating characteristics of bulk fuel equipment. You have also learned the proper uses for the items of bulk fuel equipment according to each item's nomenclature purpose, capabilities, limitations, and assembly procedures.

Answers to Study Unit #1 Exercises

Work Unit 1-1.

1. a.
2. a.

Work Unit 1-2.

1. d.
2. b.

Work Unit 1-3.

1. a.
2. a.

Work Unit 1-4.

1. a. Gasoline
   b. Jet Fuel
   c. Diesel Fuel
   d. Light Liquid Petroleum Fuels
   e. Water
2. c.

Work Unit 1-5.

1. a. Non-collapsible
   b. Cannot be coiled
   c. Has excessive weight and stiffness
   d. Not designed for positive pressure
2. c.
3. c.
4. c.

Work Unit 1-6.

1. a. Filter out contaminents
   b. Perform a coalescing action
2. b.

Work Unit 1-7.

1. c.
2. d.

Work Unit 1-8.

1. a.
2. b.

Work Unit 1-9.

1. c.
2. a.
3. c.

Work Unit 1-10.

1. d.
2. c.
3. c.

Work Unit 1-11.

1. c.
2. b.

Work Unit 1-12.

1. a.
2. b.
3. c.
4. d.

Work Unit 1-13.

1. When the tank is full and the top of the tank rests on the fuel.
2. a. One inlet
   b. One outlet
   c. One vent fitting

Work Unit 1-14.

1. d.
2. b.

Work Unit 1-15.

1. d.
2. 4-inch, 6-inch

Work Unit 1-16.

1. a. Pressure type
   b. Service station type or Gravity Fed
2. To indicate fuel flow
3. To remove sand and rust when receiving fuel over the beach from a tanker
4. To facilitate connections between suction and discharge transfer lines

STUDY UNIT 2

BULK FUEL SYSTEMS

STUDY UNIT OBJECTIVE: WITHOUT THE AID OF REFERENCES, YOU WILL IDENTIFY THE BULK FUEL SYSTEMS, THEIR DIFFERENCES, AND THEIR APPLICATIONS. IN ADDITION, YOU WILL IDENTIFY THE REQUIREMENTS FOR SITE SELECTION, CONSTRUCTION, AND INSTALLATION OF BULK FUEL SYSTEMS.

Work Unit 2-1. BULK FUEL SYSTEM SITE SELECTION

IDENTIFY TWO TYPES OF UNLOADING UNITS.

IDENTIFY BOOSTER STATION SEPARATION.

LIST THREE FUNCTIONS OF THE "LINEWALKER."

IDENTIFY FOUR TANK FARM SITE FACTORS.

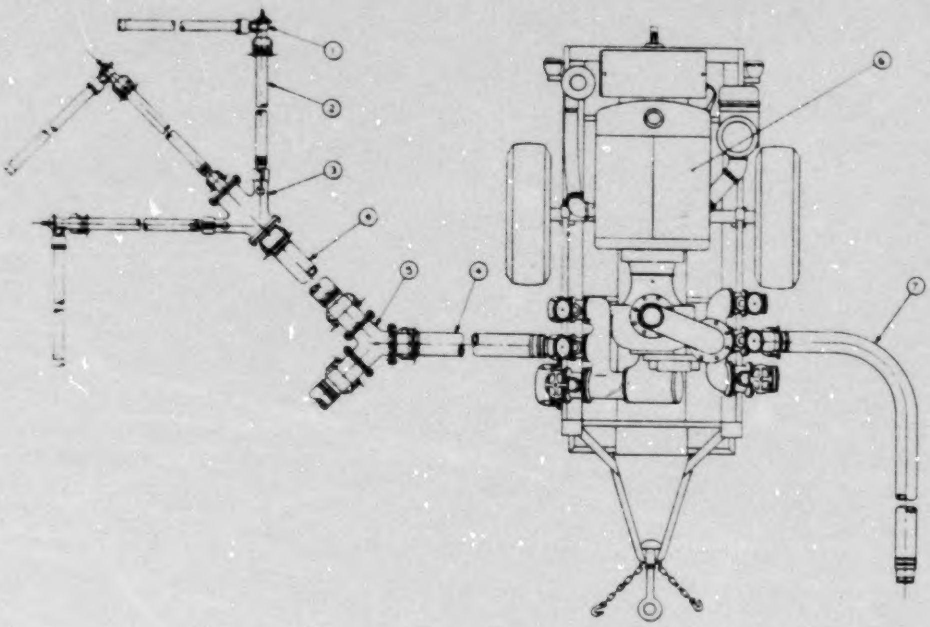
Plans of commander. Normally, before any operation, the site of the beach unloading station is given to the platoon assigned to operate all stations in the system. The commander decides which route to take from the beach to the final dispensing point. Overlays will be given by the commander to the platoon commanders and platoon sergeants, showing the terrain to be used. The terrain is the most important factor in the plans of the commander. When fuel transfer operations are carried out on very hilly terrain, the booster stations may be only 1/4 to 1/2 mile apart. After studying the plans of the commander and the general terrain features, the platoon commander selects the site for installation of the booster station and the tank farm.

Beach unloading station (fig 2-2). Terrain must accommodate amphibious craft. The site should be downwind and downstream of the main landing area to prevent endangering the entire operation through ignition of fuel vapors. The site should be removed from other congested traffic. Concealment and cover should be considered. A bottom line launching area requires an area 100 feet wide by 200 feet in depth near a level beach with a grade very similar to the natural grade of the surf zone. While plans for the beach unloading site are being made, plans must also be made to provide for the initial purge of the Navy line leading in from the tanker. There are several methods of receiving the initial purge fuel at the beach. One method is to install an extra collapsible tank at the beach to receive the initial purge (the more economical method). The fuel may be put into the main system after all of the dirt and pipe seal have settled to the bottom of the tank. Install the beach unloading station to receive the initial purge.

Unloading units. To supplement and add to the versatility of the fuel system, unloading units are used when or if the beach unloading procedures become inoperative or when a part of the system requires additional support. These unloading units can be installed anywhere in the system, provided there is a pump available.

a. Drum unloading unit (fig 2-1). This unit enables the system to be supplied by drums. Again, anywhere in the system where there is a pump, this unit may defuel six drums simultaneously.

b. Bulk tank unloading unit. This system consists of various items of hardware and accessories for unloading military and commercial trucks and rail tankers. There is no set way to assemble this defueling system; its assembly depends solely on creative thought.



1. Drum unloading valve
2. Suction hose, 2-inch x 25 ft
3. Drum unloading manifold
4. Suction hose, 4-inch x 25 ft
5. Wye, ACC
6. 600 gpm pump
7. Discharge hose, 4-inch x 50 ft

Fig 2-1. Drum unloading assembly.

Booster station. Normally, the first station installed after the beach unloading station is the No. 1 booster station. It is usually installed at a distance from the beach, dependent upon the plans of the commander, the hose allowance, and the terrain. The site should be on level terrain, if possible, and in a place that provides natural camouflage. Operations at the booster station are simple once the station is installed and ready to operate. When construction of the booster station site is completed, the tanks should be at least 120 feet apart and in berms no larger than 1 1/2 feet outside the tank. Figure 2-3 shows a booster station. The noncommissioned officer (NCO) in charge of the booster station should maintain communications at all times with other stations in the system. By doing so, the transfer rate can be controlled more readily. The rate must be about the same for all stations. If one of the stations pumps at a reduced rate, it will become overloaded with fuel. The transfer should flow evenly throughout the entire system. Booster station personnel must provide their own guards and patrols. The patrol's (more commonly known as "linewalker") mission is to guard the lines from enemy troops, inspect them for leaks, and report any incidents. The NCO in charge of the booster station selects the personnel to patrol the line and stand guard around the booster station.

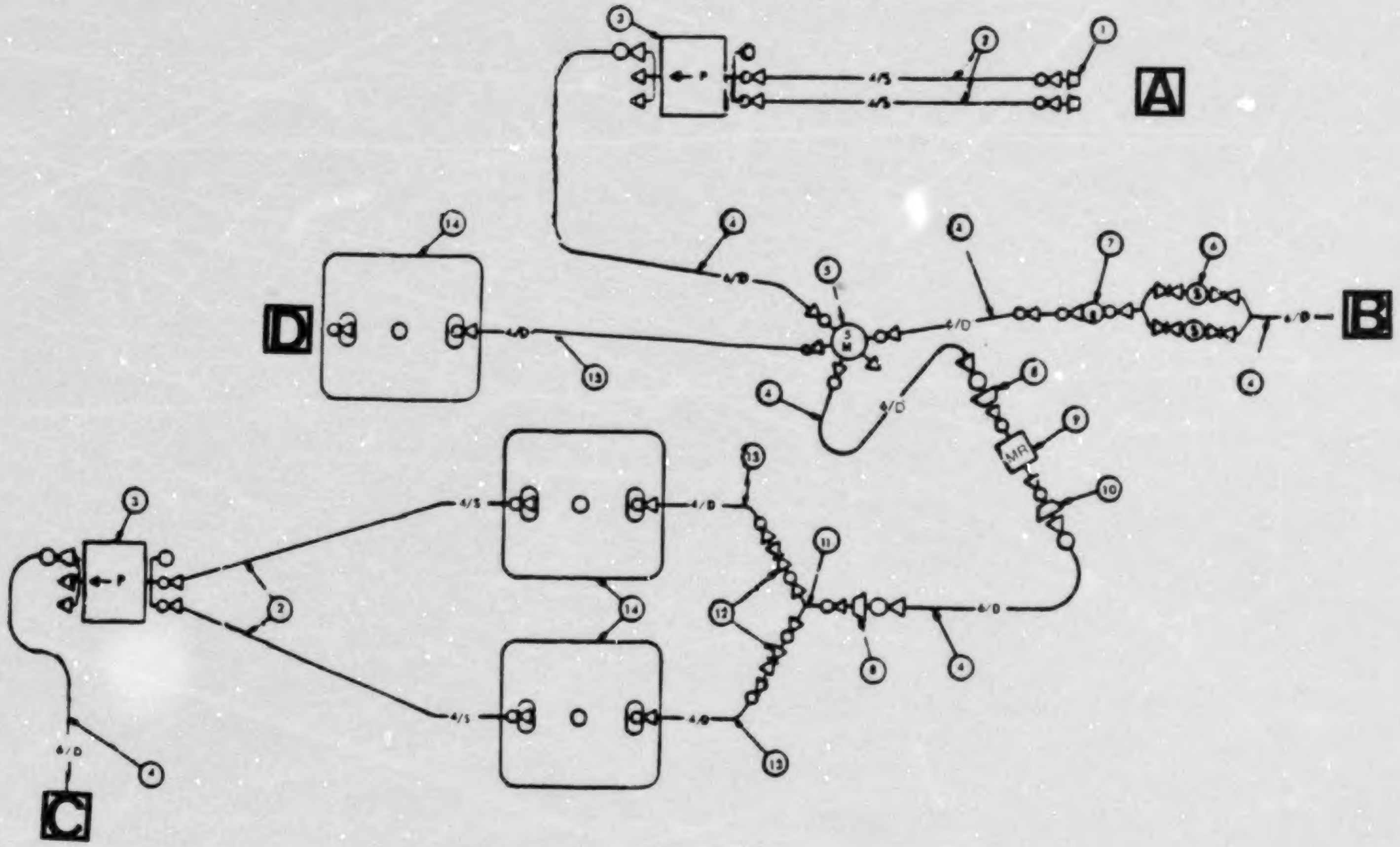
Note: The arrangement of equipment as shown is a practical method of receiving an initial purge of the fuel containing water/sediment. The method is safe and economical, as well.

A. From off-shore shuttle craft

B. Pumped from tankers or other off-shore sources

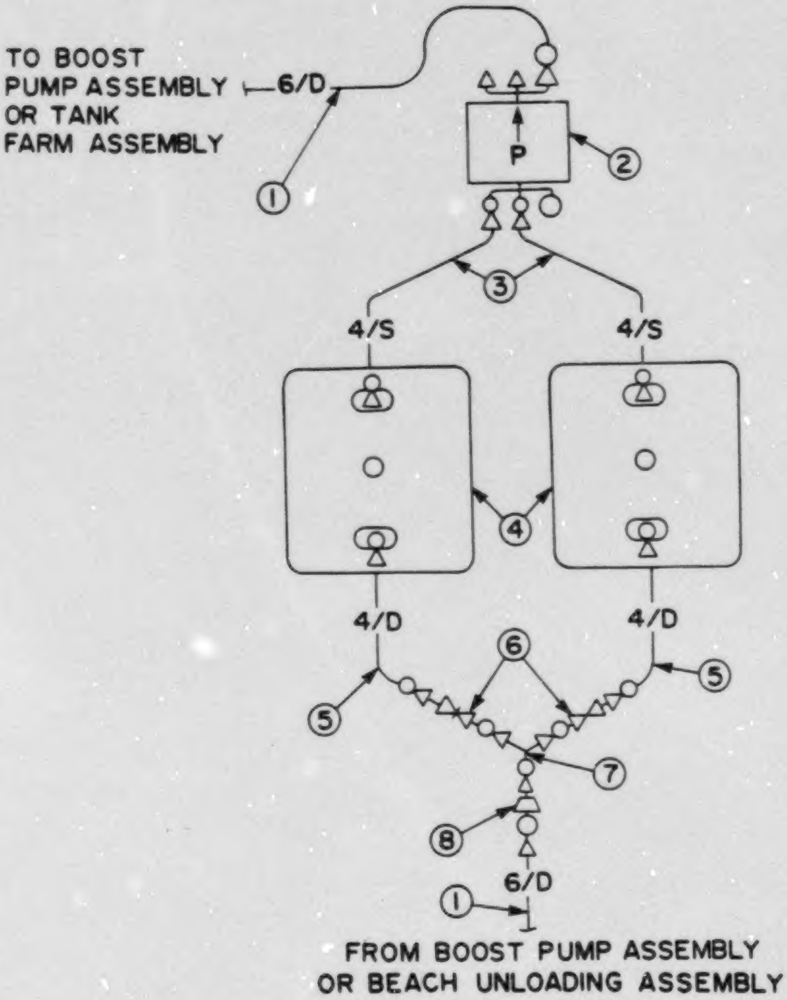
C. To boost pump assembly

D. Sump tank



1. Pressure locking nozzle, 4-inch
2. Suction hose, 4-inch x 25 ft
3. 600-gpm pump
4. Discharge hose, 6-inch x 50 ft.
5. Manifold, 6-inch
6. Strainer, 6-inch
7. Sight indicator, 6-inch
8. Reducer, 6C x 4A
9. Meter, 3-inch
10. Reducer, 4C x 6A
11. Wye, CAA
12. Gate valve
13. Discharge hose, 4-inch x 50 ft.
14. Collapsible tank

Fig 2-2. Beach unloading assembly.


TO BOOST PUMP ASSEMBLY OR TANK FARM ASSEMBLY
6/D
①
P
②
③
4/S
4/S
④
4/D
4/D
⑥
⑤
⑤
⑦
⑧
6/D
①
FROM BOOST PUMP ASSEMBLY OR BEACH UNLOADING ASSEMBLY

1. Discharge hose, 6-inch x 50 ft.
2. 600-gpm pum
3. Suction hose, 4-inch, x 25 ft.
4. Collapsible tank
5. Discharge hose, 4-inch x 50 ft.
6. Gate valve
7. Wye, CAA
8. Reducer, 6C x 4A

Fig 2-3. Boost pump assembly.

Selecting the tank farm site. The site of the tank farm should be on terrain as level as possible. Factors to be considered are: accessibility to roads for ease in dispensing fuel; dispersal for decrease in target attractiveness; and ease in berm preparation. The maximum distance from the tank farm to the dispensing point should not exceed 1,000 ft and the minimum distance should not be less than 150 ft.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. Two types of unloading units are the __________ and
   a. drum unloading unit and booster station.
   b. bulk tank unloading unit and drum unloading unit.
   c. system unloading unit and booster station.
   d. drum unloading unit and system unloading unit.

2. The booster station tanks should be placed ______________ apart.
   a. 100 feet
   b. 120 feet
   c. 151 feet
   d. 175 feet

3. The three duties of the "line walker" are:
   a. ______________________________.
   b. ______________________________.
   c. ______________________________.

4. The tank farm site has four factors that must be considered. These four factors are:
   a. accessibility to roads; ease in dispensing fuel; contour of terrain; and fuel replenishment.
   b. natural camouflage; fuel replenishment; equipment dispersal; and ease in berm preparation.
   c. equipment dispersal; contour of terrain; accessibility to roads; and natural camouflage.
   d. equipment dispersal; ease in dispensing fuel; accessibility to roads; and ease in berm preparation.

Work Unit 2-2. SITE CONSTRUCTION AND INSTALLATION

STATE TWO FACTORS IN BERM DESIGN AND LAYOUT.

IDENTIFY THREE CHARACTERISTICS OF THE BERM.

NAME TWO TANK FARM DESIGNS.

Design and layout. For fire safety, all tanks should be installed in individual berms. There are two important factors to consider in tank berm design and layout. The first factor to consider is to install the tanks in berms which will confine spilled fuel to the smallest possible burning surface and the second is to construct berms with sufficient separation so that one tank burning will not ignite any adjacent tanks. Safe tank/berm spacing is critically dependent on the interior size of the berm because of the burning surface area. Many field installations have been made with the berms spaced too close or even containing more than one tank. Enough real estate should be allocated to tank farms so that a fire in one tank will not spread to destroy the entire tank farm. Center to center tank/berm spacing of 3 3/4 times the diameter of the interior of the berm size for one tank is safe.

Many tank farms have used a radial design with six tanks installed in a circle (fig 2-4). A safer recommended arrangement is two parallel rows of three berms spaced about 120 feet on center each way, fig 2-5.

Fig 2-4. Radial tank farm.

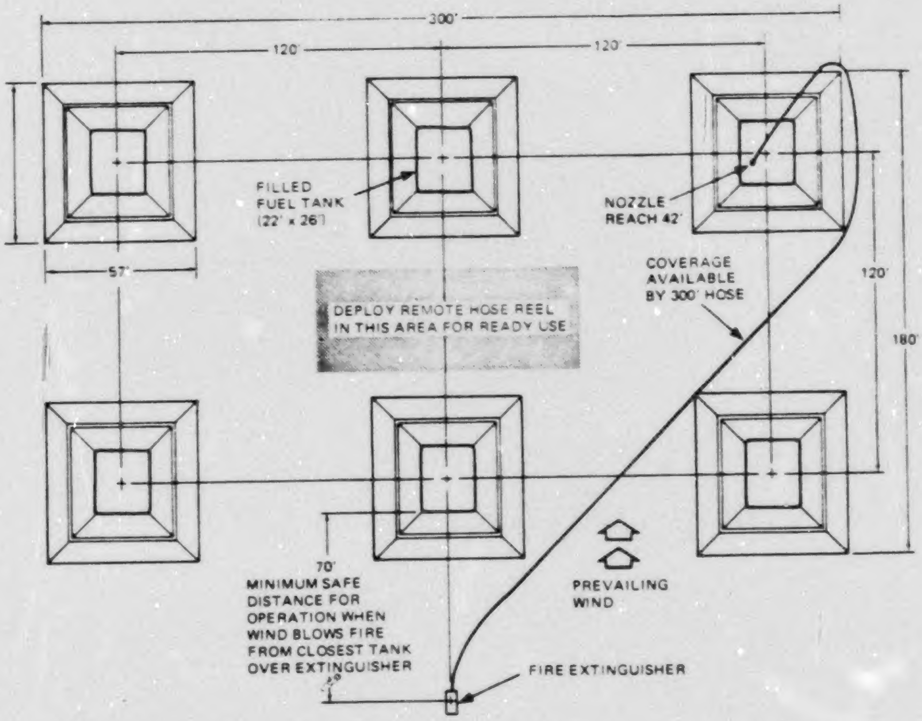
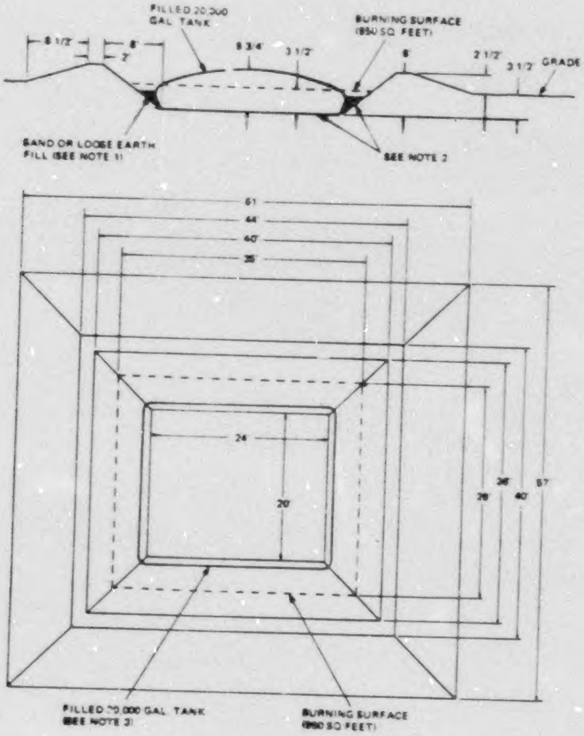

300'
120'
120'
57'
FILLED FUEL TANK (22' x 26')
NOZZLE REACH 42'
COVERAGE AVAILABLE BY 300' HOSE
120'
180'
DEPLOY REMOTE HOSE REEL IN THIS AREA FOR READY USE
70' MINIMUM SAFE DISTANCE FOR OPERATION WHEN WIND BLOWS FIRE FROM CLOSEST TANK OVER EXTINGUISHER
PREVAILING WIND
FIRE EXTINGUISHER

Fig 2-5. Parallel tank farm arrangement.

The flow of fuel from the booster station will enter one of the three coupler ports on the manifold unit. The three adapter port valves are connected to discharge hoses directed to the intake connections of six tanks. These three hoses are divided by the wye couplings so that each valve of the manifold serves two tanks. A suction hose is installed on the outlet of each tank. These hoses join into another wye coupling so that only three suction hoses need be attached to the suction ports of the pump unit. Only one discharge line is necessary from the pump unit; it may run onto another tank farm or be used to connect to the dispensing equipment. A discharge hose should be run back to the manifold unit so that the fuel can be recirculated within the tank farm.

Ground preparation and equipment placement. If the area selected for a fuel system site has shortcomings, preparing it for a fuel system could become a large earthmoving job. Since time is of utmost importance, construction is held to a minimum. Grading the area is desirable so that all the station equipment may be installed on the same plane; this can be accomplished with a tractor.

a. Tank berms. Each tank should be installed in a berm of sufficient size to contain twice the volume of a completely filled tank. The berm is formed by removing enough soil from an area to accommodate the tank to be used. The dirt removed is used to form the protective dike, the sides of which should be as steep as possible to maintain the minimum possible burning surface. The walls and floor of the berm should be smooth and compacted so as not to damage the tank. Figure 2-6 shows a berm design for the 24 x 28 foot 20,000-gallon tank. The approximate dimension of the 20,000-gallon-capacity tank is 55 feet by 55 feet. The removed soil is piled along the four sides. The inside height may be 6 feet from the bottom of the berm for the 20,000-gallon tank. The maximum outside height of the berm sill should be only 3 feet so that the berm itself does not become an obstacle to firefighting efforts. The base of these walls is about 6 feet wide. Tank berms should have a drain. A noncollapsing suction hose buried under a berm wall running to the lower outside area or a drainage ditch may be used. If a tank fails (punctures or bursts), a valve or removable hose could be used to prevent the fuel from draining into areas where it could become a fire hazard.


FILLED 20,000 GAL TANK
BURNING SURFACE (950 SQ FEET)
8 1/2'
8'
2'
8 3/4'
3 1/2'
6'
2 1/2'
3 1/2'
GRADE
SAND OR LOOSE EARTH FILL (SEE NOTE 1)
SEE NOTE 2
61
44'
40'
35'
24
20'
28'
36'
40'
57'
FILLED 20,000 GAL TANK (SEE NOTE 3)
BURNING SURFACE (950 SQ FEET)

Notes:

1. Fill with sand or loose earth after tank is filled. Support tank up to its vertical sides.
2. Compact walls and floor of berm with tracked vehicle.
3. Filled tank dimensions - 20' x 24'
   Empty tank dimensions - 24' x 28'
4. Volume of earth dug out below grade equals volume of earth in dikes above grade
5. Volume of berm equals 40,500 Gallons
6. Burning surface-950 square feet

Fig 2-6. Berm construction.

b. Tank installation. Inspect the bottom of the berm carefully and remove all sharp objects that may damage the container. Spread the ground cloth over the bottom of the berm, then unroll the tank in the berm. The tank is now ready for further assembly and filling operations.

c. Pump installation. The pump must be placed on a level firm soil. If possible, the suction manifold should be at or nearly level with the supply source in order to avoid high suction lifts which reduce the capacity of the pump; suction lifts exceeding 10 feet must be avoided, particularly in hot climates. The stand supports of the chassis are extended and chocks (stones, blocks, or timber) placed under each wheel to prevent movement during operation. Remove the ground rod from the chassis and drive it into the ground to within 3 to 6 inches of the end, and connect the grounding wire to the pump. The pump unit should be installed as close to the tanks as safety permits, normally not over 75 feet from the farthest suction port of a tank.

d. Transfer lines. The hose transfer line must be laid out along a course which provides maximum concealment. This benefit will be lost if a minimum disturbance of natural cover is not effected. It will be necessary to lay the hose around large obstructions such as boulders, trees, and heavy brush. Major obstructions such as steep cliffs or deep ravines should be avoided wherever possible. Flowing streams should be crossed, using existing bridges. If none are available, simple suspension devices should be constructed. If hillside or valley locations are possible, the route of the line will be less obvious. Adjacent wooded areas and hilly sections provide a natural background, reducing the possibility of a successful air attack. If lines cross barren or desert areas, the hose may be covered with a thin layer of sand or dirt if the surrounding color or contour of the ground are not obviously disturbed.

e. Internal lines and hardware. Internal lines and hardware must be installed so that fire lanes can be maintained to the center of the tank farm; this enables firefighting equipment to be moved to an advantageous position to fight fire. When it is necessary to cross hoses, the discharge hose must always cross over the suction hose--to prevent the discharge hose from collapsing during pumping operations. All hardware, to include the manifold, wye couplings, and gate valves, should be placed so as to allow individual control when filling or unloading tanks. Manifolds should be grounded, and all hardware placed on the ground to allow detection of leaks, but not in a manner to permit leaking fuel to form puddles.

f. Dispensing equipment. The most hazardous areas in the entire fuel system are the dispensing points, mainly because of the flow of traffic and Marines in the area who are not fully aware of the danger in fuel handling. DANGER and NO SMOKING signs must be prominently displayed, and dispensing points must be spaced at least 50 feet apart. Dispensing points are usually located near a main road and should be at least 150 feet from the main flow of traffic but easily accessible. Hose must be laid out of the way of the vehicles refueling and, wherever necessary, conduits must be used to protect the hose. Each nozzle must be secured in a holder or other device and must be properly grounded. Other items of equipment that are essential are the fire extinguisher (placed at each dispensing nozzle) and the filter separator (placed between the source of the fuel and the dispensing station).

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The two important factors to consider in tank berm design and layout are:

a. ______________________________

b. ______________________________

2. The inside height of the berm may be __________ feet while the berms outside height is ______________ feet.

a. 6, 4
b. 4, 3
c. 6, 3
d. 3, 4

3. The burning surface of the berm is ______________ square feet.

a. 900
b. 950
c. 4000
d. 4800

4. The volume of the berm is ________________ gallons.

a. 40,000
b. 40,500
c. 41,000
d. 41,500

5. Two designs used in tank farms are

a. ____.
b. ____.

Work Unit 2-3. THE AMPHIBIOUS ASSAULT FUEL SYSTEM (AAFS)

IDENTIFY THE MISSION OF THE AAFS.

IDENTIFY ONE CAPABILITY OF THE AAFS.

IDENTIFY THE CAPACITY OF THE AAFS.

When you are involved in operations where there is no source of fuel available, overland or by air, or in support of a major combat operation, the Amphibious Assault Fuel System will be set up. Figure 2-7 shows a typical fuel system from the ship to the dispensing points. The system is designed to store 600,000 gallons of petroleum product. Including all hoses and tanks at the beach unloading station and to the three booster stations, the capacity would be over 720,000 gallons. Initially, this system was designed to operate for 45 days without having to replace major components.

The primary mission of the AAFS is to supply class III and III (A) to elements of the air ground task force. This includes distribution to air bases to ensure that products delivered are of the proper type, quality, and purity.

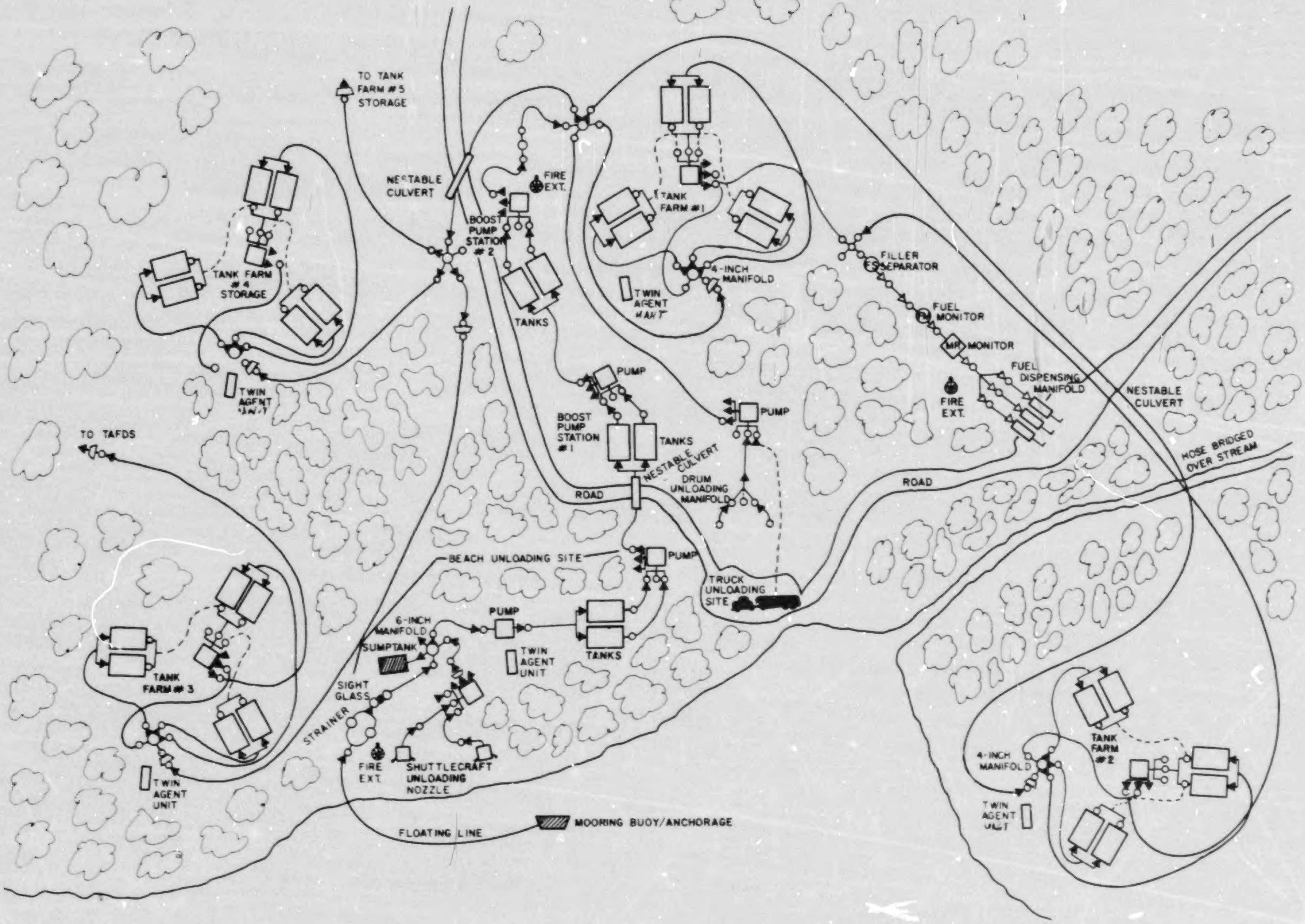

TO TANK FARM # 5 STORAGE
NESTABLE CULVERT
FIRE EXT.
BOOST PUMP STATION # 2
TANK FARM # 1
TANK FARM # 4 STORAGE
4-INCH MANIFOLD
TWIN AGENT UNIT
FILLER SEPARATOR
FUEL MONITOR
MR MONITOR
TANKS
TWIN AGENT UNIT
PUMP
BOOST PUMP STATION # 1
TANKS
NESTABLE CULVERT
PUMP
FUEL DISPENSING MANIFOLD
FIRE EXT.
NESTABLE CULVERT
TO TAFDS
HOSE BRIDGED OVER STREAM
ROAD
DRUM UNLOADING MANIFOLD
ROAD
BEACH UNLOADING SITE
PUMP
TRUCK UNLOADING SITE
6-INCH MANIFOLD
PUMP
SUMPTANK
TWIN AGENT UNIT
TANKS
TANK FARM # 3
SIGHT GLASS
STRAINER
FIRE EXT.
SHUTTLECRAFT UNLOADING NOZZLE
TWIN AGENT UNIT
TANK FARM # 2
4-INCH MANIFOLD
TWIN AGENT UNIT
FLOATING LINE
MOORING BUOY/ANCHORAGE

Fig 2-7. Amphibious Assault Fuel System (AAFS) Schematic.

The system receives fuel and equipment from seaborn ships. Tanker ships issue fuel through hoses that will either float on top of the water or lay along the ocean bottom. When the fuel reaches the beach, it is put through strainer assemblies where debris and contaminated fuel are separated into a holding tank. When the clean product appears in the sight indicator, the product is channeled through the beach unloading station and into one of five tank farms. Through the use of a central manifold, fuel can be received from a drum unloading station and tank cars and trucks. Dispensing stations will be located where they are desired or where conditions are best. Fuel is transferred to the TAFDS sites from the AAFS site when their fuel has been received.

Site selection. What you have is a problem. Imagine having to find a cove or bay deep enough to handle ships with a beach area large enough to handle 36 collapsible tanks. This could be quite an order but it is wise to remember that in combat, you will often settle for a lot less. A slight incline or river may become an obstacle, but all of the obstacles can be handled when you know your job. The AAFS can be tailored to fit the mission by either deleting or adding tanks and components.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The primary mission of the AAFS is to supply class III and III (A) to elements of the

   a. Marine Brigade.
   b. Marine Air Wing.
   c. Marine Divison.
   d. Air Ground Task Force.

2. AAFS was designed initially to operate __________ days without the necessity of replacing major components.

   a. 60
   b. 45
   c. 30
   d. 15

3. The capacity of the AAFS is

   a. 500,000 gallons.
   b. 610,000 gallons.
   c. 720,000 gallons.
   d. 800,000 gallons.

Work Unit 2-4. THE TACTICAL AIRFIELD FUEL DISPENSING SYSTEM (TAFDS)

IDENTIFY TWO PARENT UNITS OF THE TAFDS.

IDENTIFY THREE CAPABILITIES OF TAFDS.

When you work aboard a Marine Corps Air Station, you will undoubtedly work on the TAFDS. TAFDS is found in Marine Air Base Squadrons and also in the Marine Wing Support Group.

The TAFDS is air transportable, versatile, simple in arrangement and concept, and designed to meet the Marine Corps aviation fuel dispensing requirements in all probable operational or training situations. The TAFDS is based on, and entirely compatible with the Amphibious Assault Fuel System (AAFS). Like the AAFS, the TAFDS requires no tools to assemble in the field. (As you have already learned, the Kam Lock fasteners on each section of hose simplify connection.) Basically, the TAFDS system is the same as the tank farm found in the AAFS. The differences lie in the use of additional major components and accessories alloted for aircraft refueling. The TAFDS will normally receive its fuel from the AAFS, but it has the equipment to receive fuel from drums, tank cars, tank trucks, and, under certain conditions, from seagoing tankers.

Operation. The TAFDS (fig 2-8) is capable of receiving and storing 120,000 gallons of aircraft fuel and simultaneously dispensing fuel from 18 dispensing stations. Depending on the pump, the TAFDS is capable of pumping fuel at the rate of 600 gallons per minute. It is capable of refueling up to 18 aircraft at a combined flow rate of 1800 gallons per minute. The TAFDS size can be increased by the addition of systems; however, they must contain only one type of fuel. In the case of two types of fuel, two systems should be used, whether in part or totally.

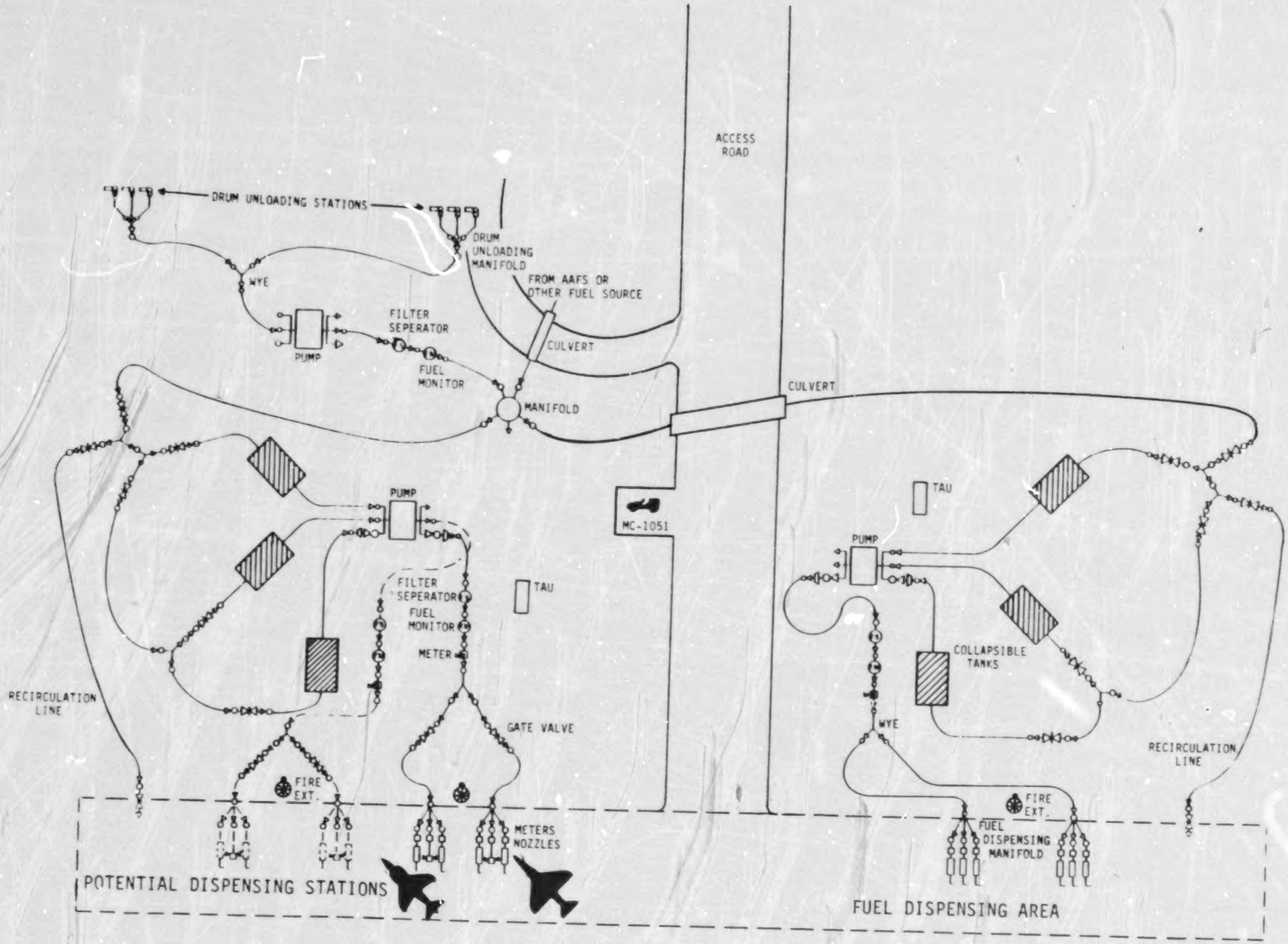

ACCESS ROAD
DRUM UNLOADING STATIONS
DRUM UNLOADING MANIFOLD
WYE
FROM AAFS OR OTHER FUEL SOURCE
FILTER SEPERATOR
PUMP
CULVERT
FUEL MONITOR
MANIFOLD
CULVERT
PUMP
MC-1051
TAU
TAU
PUMP
FILTER SEPERATOR
FUEL MONITOR
METER
COLLAPSIBLE TANKS
RECIRCULATION LINE
GATE VALVE
WYE
RECIRCULATION LINE
FIRE EXT.
FIRE EXT.
METERS NOZZLES
FUEL DISPENSING MANIFOLD
POTENTIAL DISPENSING STATIONS
FUEL DISPENSING AREA

Fig 2-8. Tactical Airfield Fuel Dispensing System (TAFDS) schematic.

Refueling. The TAFDS does two types of refueling, cold or standard and hot. The difference is as the terms imply. Hot refueling is the transfer of fuel from the TAFDS to the aircraft while the engines are running. Cold refueling is the transfer of fuel from TAFDS to a completely shut down aircraft. Fire hazards are greatly reduced in this manner. Safety precautions remain the same in either case and must be followed.

a. Hot refueling is as follows: The pilot taxis the aircraft into the fueling pits being guided by the qualified plane captain or ground crew. Aircraft must be dearmed, as well as having all electronic and electric systems turned off. Brakes must be checked to ensure that they are not hot. Ground crew as well as TAFDS personnel must ensure that there is no loose objects on the deck where they could cause foreign object damage (FOD). A grounding cable should be attached and the wheels should be chocked to prevent movement of the aircraft.

b. The nozzle operator will ensure that the ground cable is securely fastened before approaching the aircraft. The pressure nozzle is then inserted into the aircraft and fuel is pumped when the nozzle operator signals that he is ready. When refueling is complete, the fuel flow will cease upon a signal from the operator to the nozzle operator. The nozzle operator will ensure that the nozzle is disconnected and that no hazard exists before removing the grounding clamp. The ground crew will remove the chock blocks and the pilot will then taxi the aircraft out of the refueling pits. It should be noted that signals are made either by hand or by using some other safe devices because of the extreme intensity of noise and the fact that personnel are wearing hearing protection.

Site Selection. Although site selection has been covered, it should be emphasized that the TAFDS has special requirements. The TAFDS site needs to be located in close proximity to the aircraft dispensing points, usually not more than 1000 feet. Under the best conditions, the TAFDS site should not be located in any type of depression to avoid having to pump fuel up hill. The TAFDS site should be constructed according to the duration of the operation or training. This means that you have to do the best job you can in the time given.

Installation of major components. Generally, two pump units are used in the dispensing operation for the TAFDS. Each pump unit draws from three tanks. After the pump units are installed on level terrain, connect the suction hose leading from the suction port of the tank to the suction port of the pump unit. The meter assembly and filter-separators are installed between the pump unit and the dispensing point. The meter assembly is the last major component installed before the dispensing nozzles. All major components of the TAFDS are equipped with the standard 2- and 4-inch couplers and adapter quick connectors. The filter-separator should be installed ahead of the meter assembly to filter out all sediment and dirt in the fuel to prevent damage to the meter assembly. The fuel monitor is always installed after the filter-separator and generally, but not always, before the meter assembly.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The two places where the TAFDS is found are the

   a. MWSG and MABS.
   b. MWHS and MWSG.
   c. MACS and MABS.
   d. MWCG and MACS.

2. The TAFDS is based on and entirely compatible with

   a. HERS.
   b. AAFS.
   c. FOD.
   d. HSFRS.

3. TAFDS is capable of refueling up to _______ aircraft at a combined flow rate of 1800 gallons per minute.

   a. 8
   b. 18
   c. 12
   d. 20

4. The TAFDS does two types of refueling. These are standard and

   a. high speed.
   b. quick.
   c. hot.
   d. endurance.

Work Unit 2-5. THE HELICOPTER EXPEDIENT REFUELING SYSTEM (HERS)

IDENTIFY TWO CHARACTERISTICS OF HERS.

Sometime in the future, you may be called upon to set up a HERS system (fig 2-9). The system itself consists of most of what you have learned in previous work units. While the equipment and its usage is the same, the mission and the locale you will be working in will be different. This system was initially designed to refuel helicopters at advanced bases and remote locations. With the introduction of the AV-8 Harrier aircraft, HERS took on an expanded mission. The HERS can be set up at any location that the Harrier can operate from. This is necessary because the Harrier can takeoff vertically and needs no runway and it can be employed in forward areas.

The HERS can be found containing either the 50-to 100-gpm pump. The 50-gpm pump is fine for helicopters, but the flow rate is insufficient for the Harrier. Therefore, if you know that you will be refueling the Harrier, make sure that the 100-gpm pump is available.

Operation. Try to select a level area in close proximity to the aircraft refueling area. This is important since the suction hose consists of 24 two-inch by ten-foot sections and the discharge hose consists of 6 two-inch by fifty-foot sections.

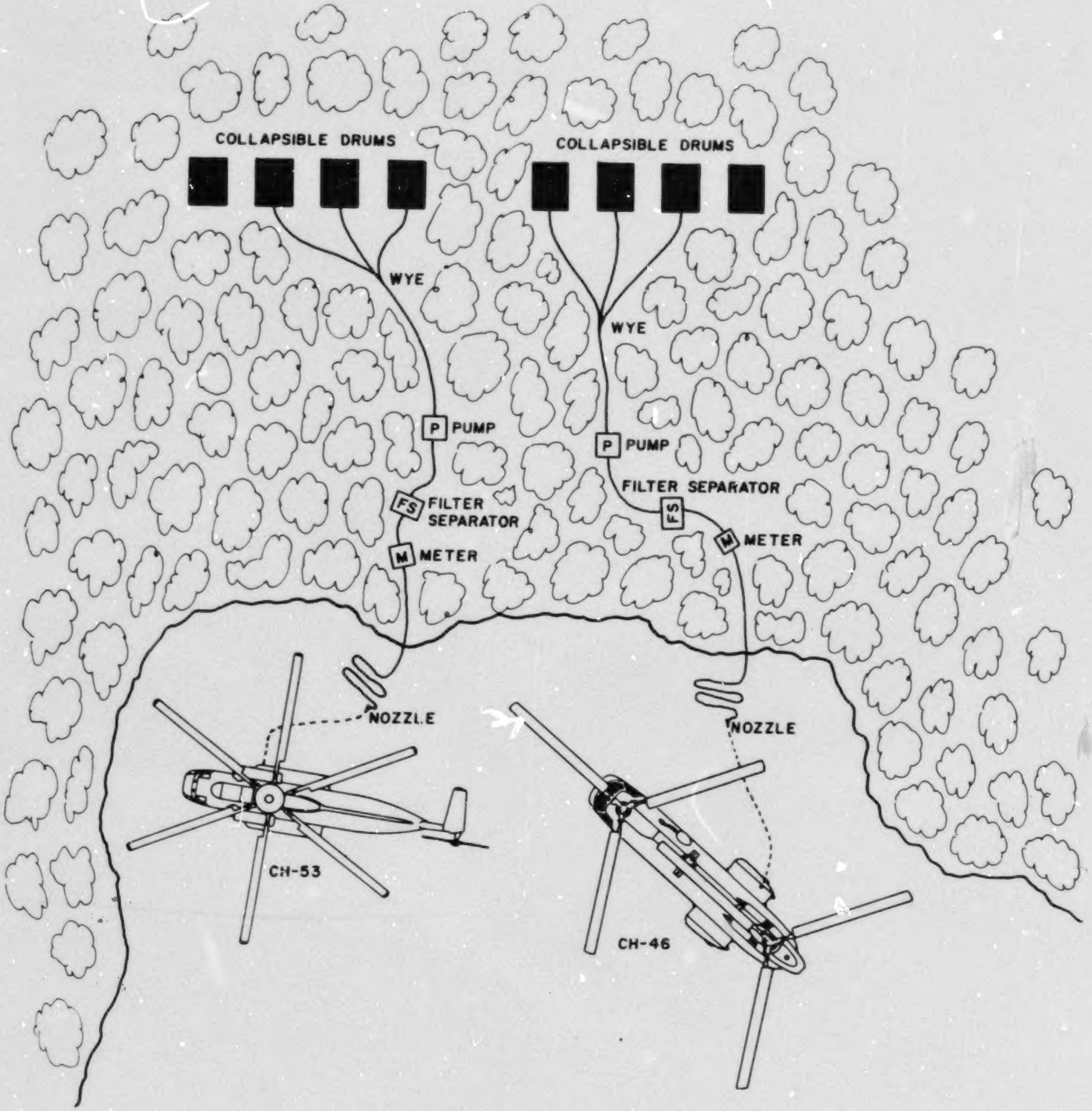

COLLAPSIBLE DRUMS
COLLAPSIBLE DRUMS
WYE
WYE
P PUMP
P PUMP
FS FILTER SEPARATOR
FILTER SEPARATOR FS
M METER
M METER
NOZZLE
NOZZLE
CH-53
CH-46

Fig 2-9. Helicopter expedient refueling system.

This gives you 540 feet of hose to use for the system.

Place the pump and connect 4 of the 18 drums, wyes, and hoses as shown in figure 2-9. Drive the ground rod into the ground and connect it to the pump. Now connect a 50-foot hose to the pump on the outlet side. Position the filter-separator and attach a ground wire leading to the ground rod. Attach the discharge hose to the inlet side of the filter separator, from the pump. At the same time, connect the hose from the outlet side of the filter-separator to the nozzle and you are ready to go. Most refueling will be hot so you must take all precautions that you learned for the TAFDS, but most importantly, you must provide the ground for the aircraft to reduce the possibility of static discharge.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The 50-gpm pump should not be used to refuel the Harrier because of its

a. size.	c. flow rate.
b. power.	d. static discharge.

2. The HERS contains ________ fuel drums.

a. 6	c. 18
b. 12	d. 24

Work Unit 2-6. THE HIGH SPEED FIXED REFUELING SYSTEM

IDENTIFY TWO CHARACTERISTICS OF THE FIXED SYSTEM.

When you work at a fixed refueling system, you will quickly note the absence of bulk fuel equipment. These systems are located usually aboard Marine Corps Air Stations in varying designs. These systems are not deployable but have a very efficient track record. Although you may think that no two fixed systems are exactly alike, you will find that this is not true when you look into the mechanics of the system (see fig 2-10 A-C). The hoses are replaced by pipelines, a steel or concrete tank replaced the fabric tanks, filter-separator and gate valves are built in. Since you can now identify the equipment and you already know the function of each, there should be no problem.

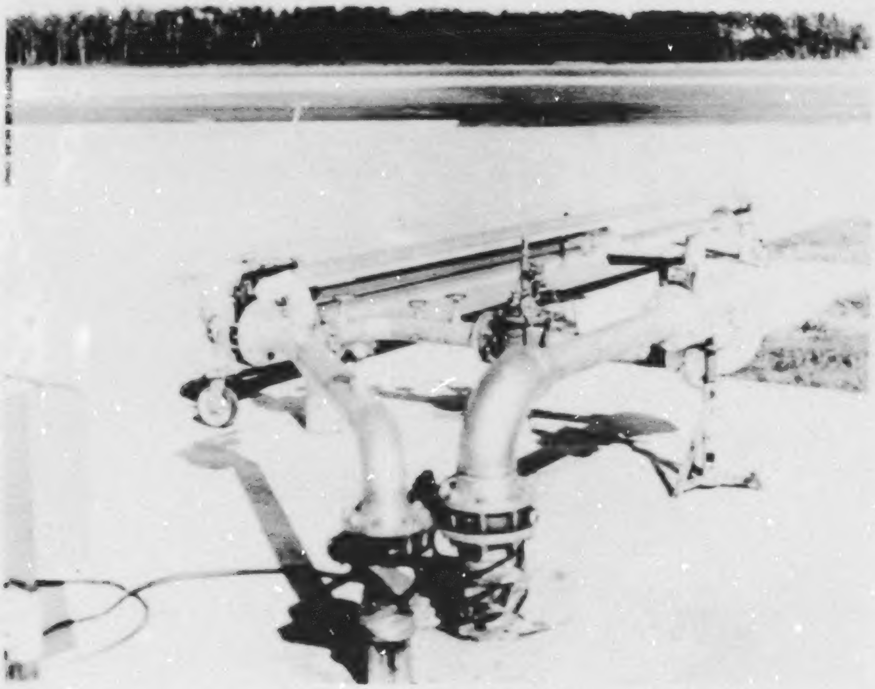


Fig 2-10A. High speed fixed refueling system.

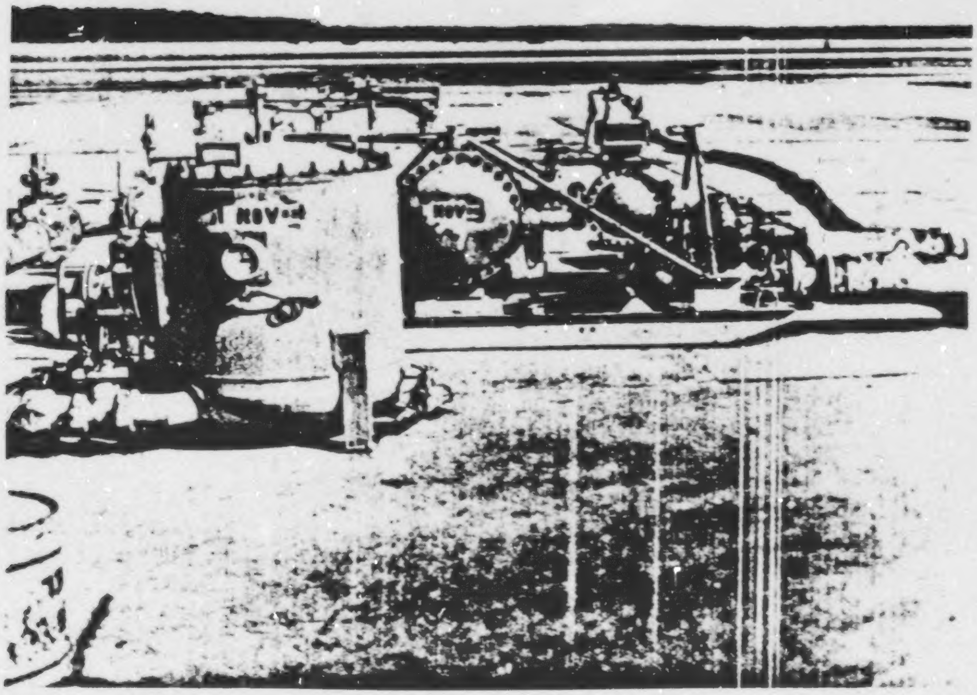


Fig 2-10B. Closeup showing filter-separator, meter, and components of the high speed fixed refueling system.

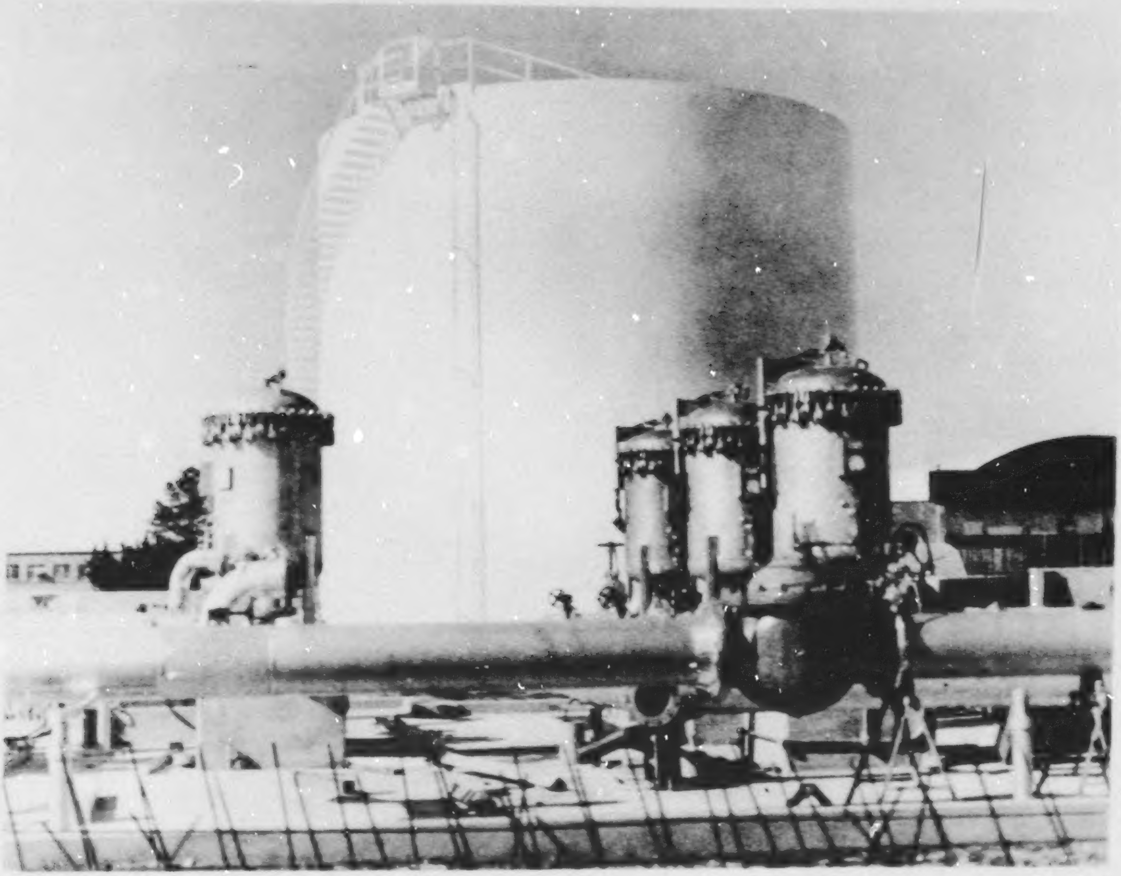


Fig 2-10C. New system at MCAS Cherry Point, NC.

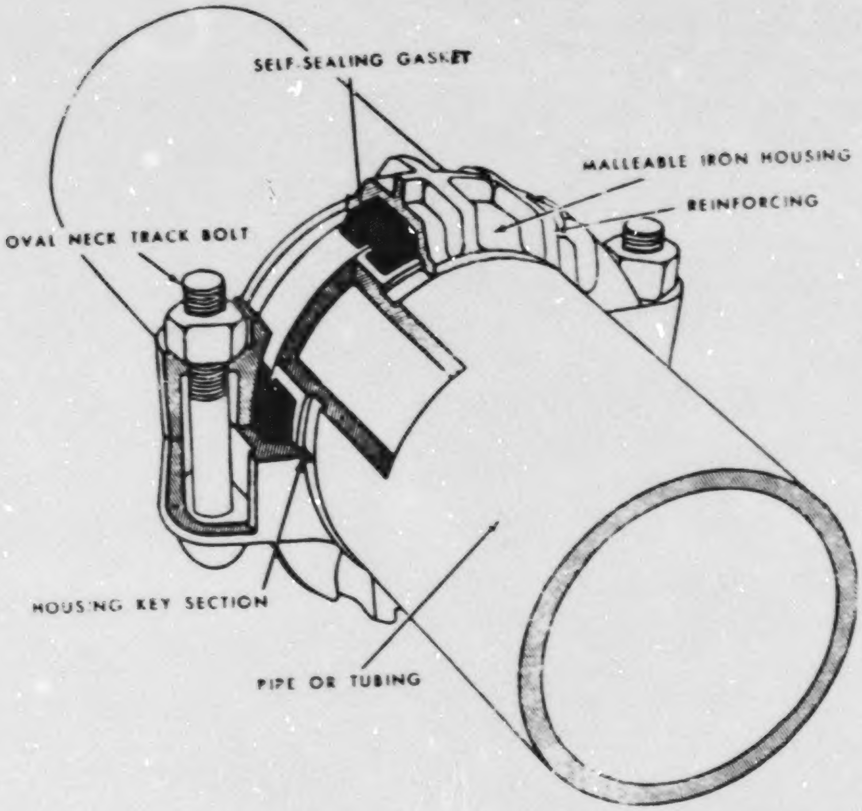

SELF-SEALING GASKET
MALLEABLE IRON HOUSING
REINFORCING
OVAL NECK TRACK BOLT
HOUSING KEY SECTION
PIPE OR TUBING

Fig 2-11. Typical pipeline repair clamp.

Maintenance. Maintenance is basically the same with the exception that the hose and pipeline are repaired differently. On the pipeline, maintenance is required for leaking couplings, split joints, cracked welds, corrosion, and erosion. The lines must be inspected daily for leaks. Varying types of clamps that bolt to the pipeline (fig 2-11) are used as an expedient method, but the section or area that is leaking must be replaced or removed and repaired. The pipe that is removed can be rewelded for repairs as shown in figure 2-12A. Pipeline that is temporarily shut down will have a blind or circular stop plate bolted to the end of the piping assembly to prevent the leaking of additional fuel.

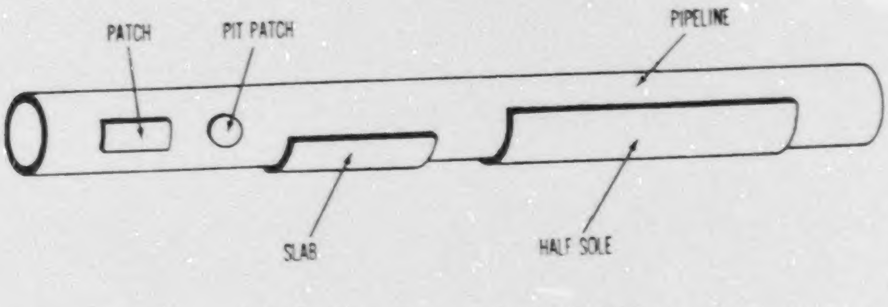

PATCH
PIT PATCH
PIPELINE
SLAB
HALF SOLE

Fig 2-12A. Pipe repaired by welding.

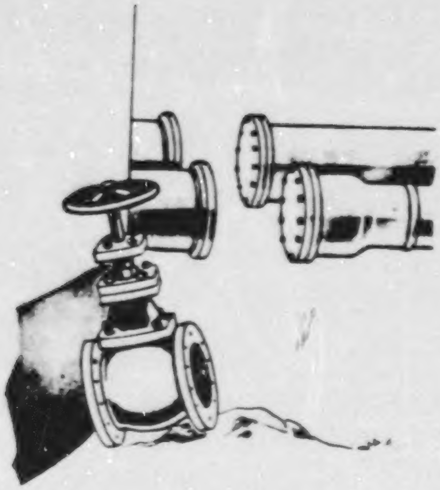
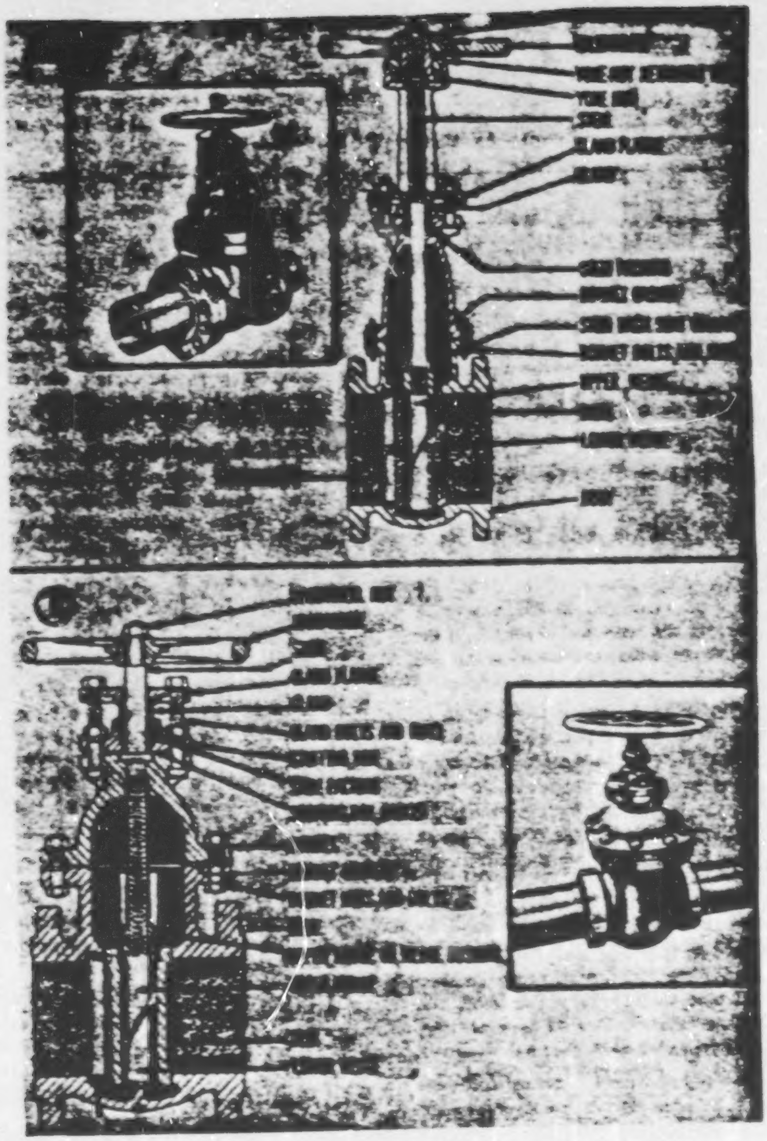


Fig 2-12B. Valve removed with blinds in place.

Valve (figure 2-13 A through E should be used when identifying the different types of valves as follows). Used in the system, may be rising stem, non-rising stem, globe valves, plug valves, and check valves. Rising stem and non-rising stem are gate valves. The rising stem (fig 2-13A) is basically the same as that used on a pump. Inside these two gate valves there is a difference. The difference being that on one the stem rises with the internal disk that allows fuel flow. On the non-rising stem (fig 2-13B), the disk is opened, allowing the fuel to flow while the stem remains in the same position. This is caused by threaded grooves meshing between the stem and the disk, much like a nut being screwed on a bolt. A globe valve (fig 2-13C) is like the valve located on a sink faucet. It is used to throttle or regulate the flow of fuel. The difference here is that the disc is located in a horizontal position on the end of the stem rather than vertically as in the gate valves. Usually, the globe valve is not located on the main pipeline since it hampers cleaning.



A. Rising stem gate valve
B. Nonrising stem gate valve
Fig 2-13. Valves.

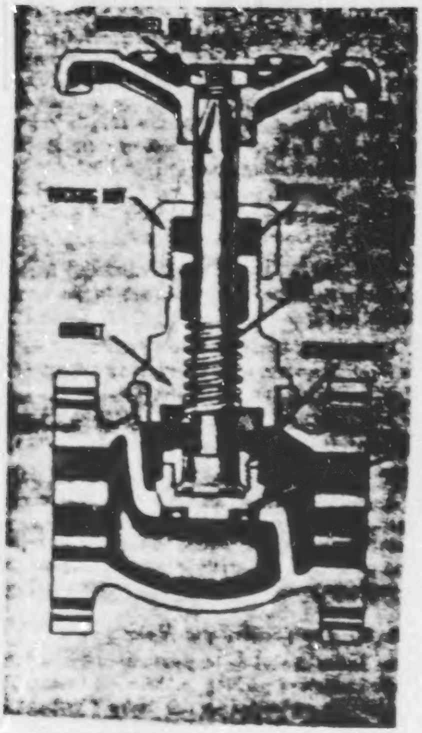


Figure C *Globe valve.*

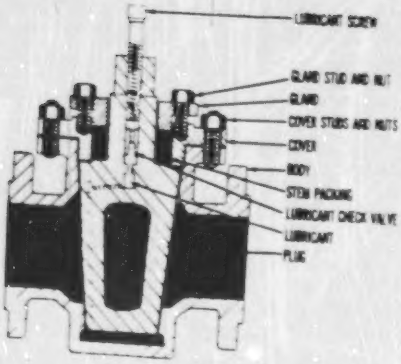


Figure D *Plug valve.*

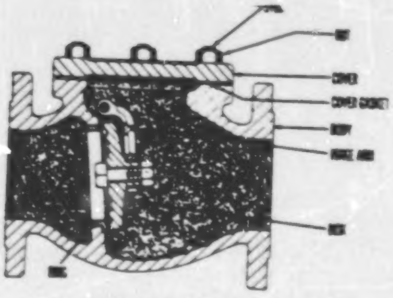


Figure E *Check valves.*

Fig 2-13 (cont'd). Valves.

Plug valves (fig 2-13D) do not have a handwheel to turn. Instead, there is a stem nut that is turned by use of the plug wrench. This nut is turned only a quarter turn to close or open the fuel flow. It cannot be used for throttling the fuel since the only reliable positions are opened and closed. This valve is used mainly at the storage tank because it also hampers cleaning efforts. The check valve (fig 2-13E) keeps fuel flowing automatically in one direction. Flow is shown by an arrow located on top of the check valve. A hinged disk opens to allow the fuel to flow. If the fuel flows back, this hinge closes, thereby regulating the direction of flow.

Storage tanks are often the most imposing feature of the system. Figure 2-14 shows a typical tank structure and the different features that each tank may have. The ladder allows access to the top of the tank. On the top are basically three openings: one is the vent, in the center is the access hatch cover, and near the top of the ladder is the gaging hatch. The gaging hatch is used for fuel sampling as well as a visual assurance of the quantity of fuel. The access hatch is generally used for cleaning and purging the tank of vapors while cleaning. The vent allows for the equalizing of pressure while the tank is being filled or emptied. Around the base of the tank is a water drain-off valve which is used to do exactly that, drain water. The access plate is removed when the tank is empty. This allows for purging the tank, access for personnel to clean the sludge, and preventive maintenance and inspection of the interior of the tank itself. The feeder line or supply line both deliver and issue fuel through use of the pipeline. Around the tank area, there is a clear space with a bermed area. This is the firewall or berm as you are used to calling it. This bermed area has the same function as that of a collapsible tank. Drains are used in the same manner, although the equipment may be different.

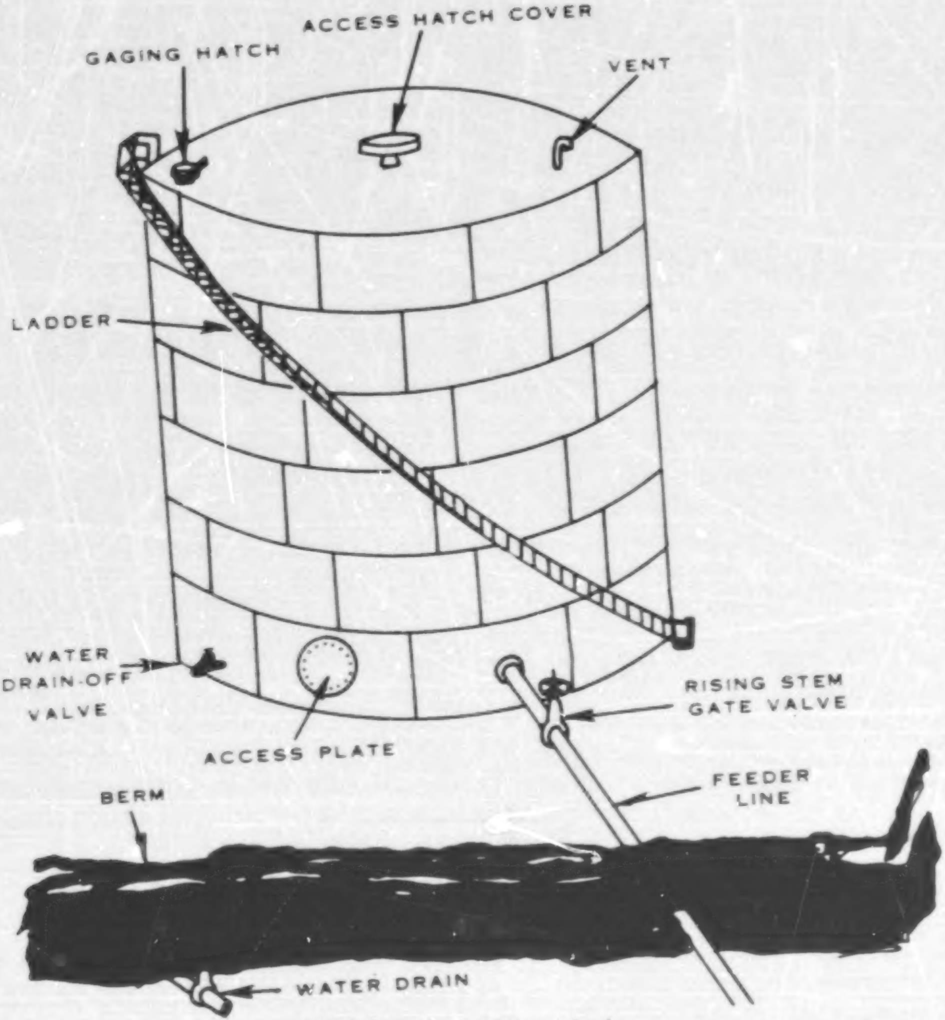

ACCESS HATCH COVER
GAGING HATCH
VENT
LADDER
WATER DRAIN-OFF VALVE
RISING STEM GATE VALVE
ACCESS PLATE
FEEDER LINE
BERM
WATER DRAIN

Fig 2-14. Fuel storage tank.

A great deal of care must be exercised when working around the storage tank. Personnel working on the top of the tank should use a safety line to prevent themselves from falling off of the tank. The berm around the tank must be maintained and repaired if any erosion starts. Above all, when cleaning the tank, you must follow established procedures to prevent mishaps from occurring. These procedures are established locally so make sure that you know them.

The pipelines at the system are color-coded to prevent accidental issue of the wrong product. Table 2-1 shows the standard color coding as set up by the Department of Defense. Ensure that you know the proper identification of the product by the color coding of the pipelines.

Table 2-1. Pipeline color coding

Aviation gasolines - 1 yellow band

Automotive gasolines - 2 yellow bands

Jet fuels - 3 yellow bands

Diesel fuels - 4 yellow bands

Multi-product lines - 1 wide yellow band

(In addition to the yellow bands, the product name is printed in white on a black background.)

Refueling. The procedures that were used for TAFDS are the same. Both standard and hot refueling are routinely handled. The difference will mainly be the apparatus that the nozzle and hose are attached to. This may be just a fixture coming out of the ground, or a long hose from the stationary equipment. In any case, you will need to familiarize yourself with the operating characteristics of the system you are using. Figure 2-15 shows refueling operations on the A-6 aircraft using this system. As in TAFDS, you should familiarize yourself with the aircrafts that need refueling and their characteristics.

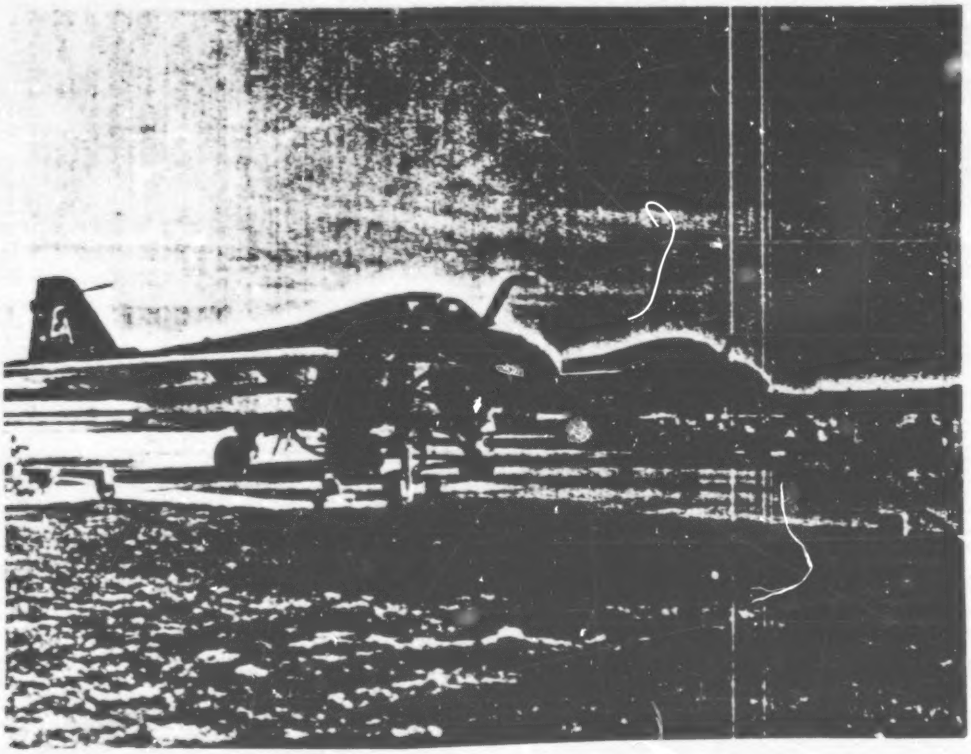


Fig 2-15. Refueling the A-6 aircraft.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The major identifiable characteristic of the fixed system is that

   a. equipment is permanently mounted
   b. equipment is quickly moved
   c. equipment is deployable
   d. all systems are exactly alike

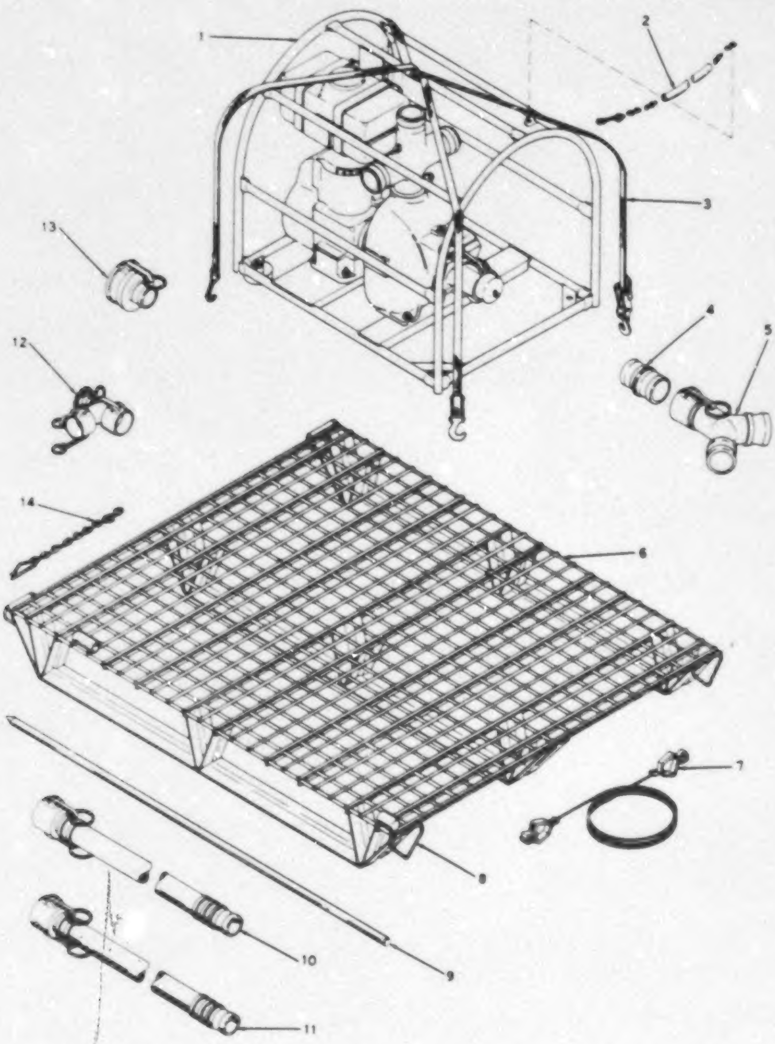
2. Equipment of the fixed system performs the same function as a TAFDS system; however, it is

   a. harder to maintain.
   b. non-deployable.
   c. painted to match the aircraft.
   d. limited by the length of the hoses.

Work Unit 2-7. THE EXPEDIENT REFUELER SYSTEM (ERS)

IDENTIFY TWO CHARACTERISTICS OF ERS.

Although you may seldom see the ERS in peacetime, it could be one of the most widely used systems in combat. This system can be as quickly set up as a vehicle refueling point. Originally, this system was shipped on a metal skid as shown in figure 2-12; however, it now can be found stored in may different setups. The pump unit is the standard model for the 50-gpm, model 803. It has a 2 1/2-horsepower engine driven by gasoline. The system is provided with one 2-inch suction hose and two 2-inch discharge hoses. The pump assembly is designed to pump gasoline, kerosene, or JP type fuels at the rate of 50-gpm at 81 feet TDH (total dynamic head). Although this system may actually be part of the HERS, it should not be used in place of the HERS. You should be aware of this subsystem as a separate piece of equipment. In the future, the 100-gpm pump will be the main pumping unit on this item of equipment.



1. Pumping unit
2. Accessories chain
3. Retaining strap
4. Male adapter
5. Hose Y-connection
6. Skid base
7. Grounding wire
8. Ground rod retainer
9. Ground rod
10. Suction hose
11. Discharge hose (2)
12. Coupler valve
13. Adapter coupler
14. Chain assembly

Fig 2-12. Breakdown of the expedient refueler.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The ERS is a separate system, yet it resembles components of the

   a. TAFDS.
   b. AAFS.
   c. fixed system.
   d. HERS.

2. The expedient refueler pump was designed to pump gasoline, kerosene, and

   a. diesel.
   b. petroleum.
   c. JP.
   d. AVGAS.

SUMMARY REVIEW

You can now identify the various bulk fuel systems (the AAFS, TAFDS, HERS, and the ERs). You have learned the differences between the systems and the operations of each system. You have also learned the requirements for site selection, construction, and how to install various bulk fuel systems.

Answers to Study Unit #2 Exercises

Work Unit 2-1.

1. b.
2. b.
3. a. Report any incidents
   b. Check lines for leaks
   c. Guard lines from enemy
4. d.

Work Unit 2-2.

1. a. Install tanks in berms that will confine spilled fuel to smallest possible area
   b. Construct berms with sufficient separation so that one tank will not ignite an adjacent tank.
2. c.
3. b.
4. b.
5. a. radial
   b. parallel rows of three

Work Unit 2-3.

1. d.
2. b.
3. c.

Work Unit 2-4.

1. b.
2. b.
3. b.
4. c.

Work Unit 2-5.

1. c.
2. c.

Work Unit 2-6.

1. a.
2. b.

Work Unit 2-7.

1. d.
2. c.

80

STUDY UNIT 3

FUEL HANDLING PROCEDURES

STUDY UNIT OBJECTIVE: WITHOUT THE AID OF REFERENCES, YOU WILL IDENTIFY FUEL TRANSFER METHODS, QUALITY CONTROL PROCEDURES, AND FUEL SAMPLING PROCEDURES. IN ADDITION, YOU WILL IDENTIFY BULK FUEL STORAGE TECHNIQUES.

Work Unit 3-1. FUEL TRANSFER PROCEDURES

STATE TWO METHODS OF TRANSFERRING FUEL FROM SHIP TO SHORE.

LIST FOUR METHODS OF RECLAMATION OF FUEL.

LIST FOUR METHODS OF FUEL DISPOSAL.

SHIP TO SHORE

You should know the two methods used to transfer fuel from ship to shore. The first method used at the beginning of a landing or an operation is the floating-line method and the second method used is the bottom-laid line method.

Floating-line method. Installing a floating line from ship to shore is a method used to replace the ferrying method. It consists of a 6-inch lightweight gasoline discharge hose in 250-foot lengths connected with aero-quip fittings. Tension on the hose is relieved by a 1/2-inch wire rope attached by cable clips to D-rings embedded in the hose. The assembled hose and relief cable are flaked down (a manner in which the hose is placed to eliminate any entanglements) in the landing craft and laid aid out over the stern as the craft moves from shore seaward (fig 3-1). (Some units may have the new hose reel which has 5,000 feet of 6-inch hose. This allows the hose to be laid much more quickly.) The tension line on each 250-foot section is attached to an anchor. Special floater hoses are attached to the assembly on 50-foot centers so that the hose is suspended approximately 2 to 3 feet below the surface when filled with fuel. Although this method is a major improvement over the ferrying method, it does have the following deficiencies: (1) installation of the hose from a landing craft in other than calm seas is difficult and hazardous; (2) the floating hose is vulnerable to enemy action, moderate seas and cross-traffic of surface craft; and (3) the hose is relatively easy to detect. One advantage of the floating-line method over the bottom-laid is that it can be installed much faster.

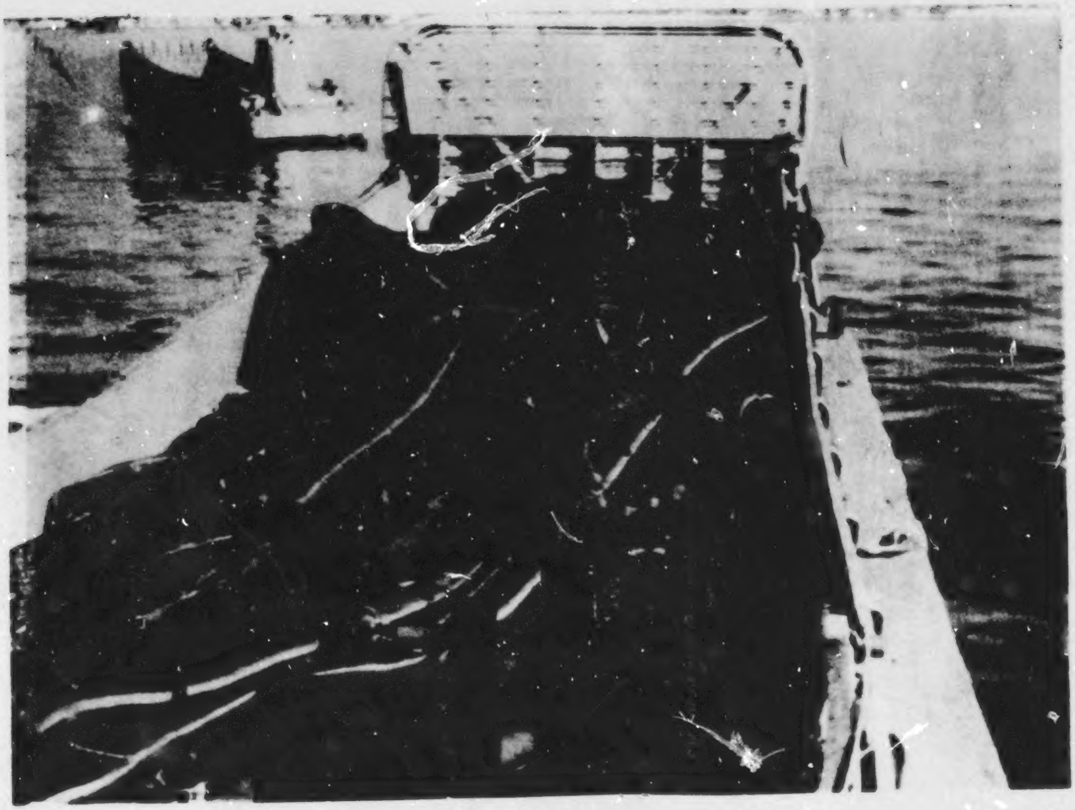


Fig 3-1. Floating line.

Bottom-laid line method. The second method of transferring fuel from ship to shore is the installation of the bottom-laid line. This method is generally regarded as the best means of transfer, and it remedies the shortcomings of the other method. This method consists of all material necessary to install 5,000 feet of 4-inch submarine pipeline. Each section is 30 feet long and can be joined by hand to within 2 threads of complete makeup by the use of couplers within plated threads. Actual assembling of the line begins on the beach after unloading procedures are followed. The line is flexible enough to permit assembly of up to 150 feet in length. By the use of a tow hose assembly with a tension cable, it is towed seaward by a warping tug or fleet tug (fig 3-2). The use of telephones assists in the operation and guidance.

Fig 3-2. Warping tug towing pipeline to sea.

a. Beach unloading station to dispensing station or tank farm. Every effort must be made to preserve the original quality of the fuel you are handling. Proper handling is the key quality. This cannot be overemphasized and it is every bulk fuel man's responsibility to make sure that his equipment is ready to receive and transfer fuel. A final check should be performed on lines for damage and possible repair or replacement; connections should be inspected for dirt or sand and placed in such a way that leaks can be detected easily when fuel is being transferred. All tanks, regardless of type, should be clean and ready to receive and store fuel. Equipment should be properly grounded and all necessary safety precautions considered. The major problem in fuel handling becomes one of maintaining fuel quality rather than detecting contamination (which is mainly caused by carelessness).

b. Reclamation procedures. Reclamation is the application of principles and knowledge relative to fuels and lubricants, in conjunction with reclamation equipment, in order to convert a product of questionable quality into a usable product. When a product has been condemned as unfit for use, its disposition must be decided upon by the CO of the using unit and the quality control section of the bulk fuel company.

The process of reclamation, when properly applied, will result in one of the following:

(1) Downgrading. Downgrading is the procedure by which an off-specification (off spec) or slightly contaminated petroleum product is approved for use as a lower grade of the same or similar petroleum product.

(2) Blending. Blending is that procedure by which predetermined quantities of two or more similar petroleum products are mixed to produce a petroleum product of intermediate grade or quality.

(3) Purification. Purification is the removal of contaminating agents by filtering, inhibiting dehydrating, or blending.

(4) Dehydration. Dehydration is the removal of water by filtering or settling process. Water in most light petroleum products will settle out if allowed to stand undisturbed from 12 to 24 hours. If the light product is in a storage tank, the excess water may be withdrawn through the water draw-off valve. If the product is in a small container, the water may be separated by filtering and decanting into another container or by siphoning off the water.

c. Disposal. If a product is definitely declared unfit for use or further reclamation as fuel requiring less quality, the CO and the quality control sections of the bulk fuel company must decide how to dispose of it. If it is an oil product, it may be used for roads. If it is gasoline or JP-4, it may have to be burned, buried, or transferred to another area by fuel trucks, depending on the terrain, weather, or tactical situation. In some cases, it may be mixed with fuel oil (not to exceed 10% ratio) for use in stoves.

It must be noted the above stated disposal methods do not apply when working at your fuel farm. One of the major concerns that you should have is the ecology of the area. Burying fuel is not appropriate since the fuel may get into the water supply and contaminate it. Additionally, plant and animal life are threatened by the leaks or spills of petroleum products. Therefore, fuel is usually transferred to a site where it can be processed into a reusable product. Occasionally, wasted fuel is used for training purposes in firefighting techniques. The difference in disposal is the difference between a tactical situation, such as combat, and your normal workday routine at the fuel farm.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The two methods of transferring fuel from ship to shore are by ______________ and ______________.

2. The four procedures used to reclaim fuel are:

   a. ____
   b. ____
   c. ____
   d. ____

3. In a tactical situation, fuel may be disposed of by four techniques. These are:

   a. ____
   b. ____
   c. ____
   d. ____

Work Unit 3-2. QUALITY CONTROL PROCEDURES

IDENTIFY WHO IS RESPONSIBLE FOR QUALITY CONTROL.

IDENTIFY TWO PROBLEM AREAS IN FUEL QUALITY CONTROL.

Since the major function in every part of the bulk fuel man's job is to ensure the quality of the product, you should be aware of the different factors that affect the condition of fuel. Contamination of petroleum products in the fuel system is mainly caused by carelessness on the part of personnel in cleaning the tanks and hoses in the system. The greatest danger of products becoming mixed is in the tanker compartments. The bulk fuel man cannot control this factor but he should be aware of it. The sources of contamination are normally dirt, rust, water, or another petroleum product.

Water. Water contamination is unavoidable. A certain amount of water leakage occurs in the tanker and water is used to flush the dirt and debris from the ship-to-shore fuel line. Present line-flushing techniques in the AAFS and TAFDS also require the use of water. Water can enter open or damaged containers, or condensation in metal containers due to temperature changes and humidity may be sources of water. Water is easily detected and will settle out of most light petroleum products and can be removed with a small pump. Filter-separators will remove the remaining entrapped water.

Dirt. Dirt and sand, present in fuels, may be the result of carelessness, inadequate cleaning and inspection of tanks or containers, failure to close small containers, the use of muddy water to flush hoses, or sabotage. This type of contamination is unavoidable due to the inherent characteristics of the equipment. Dirt in light fuels, such as gasoline, will settle out in a relatively short period of time. In heavier fuels, such as diesel or jet fuel, filtering is required to remove the smaller and lighter weight particles. Rust may come from corroded tanks, pipe or any iron and steel in contact with the fuel and water. Rust can be removed by the same methods employed for dirt.

Other products. Contamination by mixing of different fuels in tanks, hoses, or other equipment is difficult to detect under field conditions. This problem can be minimized by strict adherence to one cardinal rule: Complete separation of products. Separate pipes, hose, tanks, and other equipment must be established and maintained for each type and grade of fuel. However, there is an exception to this rule. On occasion where only a single AAFS/TAFDS is in operation, different fuels may be transferred in succession without contamination being too great of a problem. Lighter fuels, such as AVGAS 115/145, must be pumped first; then heavier fuels, such as diesel may be pumped. The converse is not applicable. It would be necessary to purge the hose and tanks before changing from diesel to AVGAS. In any case, the student is reminded that one fuel, one system, is desirable and necessary for simultaneous transferring and storing of different fuels.

Deterioration. Another cause of fuel being "off spec" is deterioration. A considerable period of time is essential to produce any significant deterioration or chemical change. The detection of these changes is difficult without adequate laboratory facilities. Due to a relatively short period of time involved from the shipping control test until consumption by the expeditionary force, deterioration is not likely to present a serious problem. Deterioration through loss of additives, tetraethyl lead, and color has been known to occur during storage of petroleum products. The causes are not definitely known. When fuel is stored for an excessive period of time, the loss of additives, such as oxidation inhibitors, decreases the safe storage time of a fuel because of the possibility of early gum formations. The loss of tetraethyl lead decreases the power-producing characteristics of a fuel and is indicative of very serious deterioration, especially in aviation fuels. The detection of this type of loss is complex and requires the use of special test engines and equipment. Loss of color has no importance other than the psychological effect upon the ultimate user, who usually distrusts a petroleum which has lost its color.

Weathering. Weathering is the loss by evaporation of the more volatile components of petroleum products. The effects of weathering are most noticeable in aviation and motor gasolines. All storage tanks are vented to prevent rupturing the container when the more volatile components evaporate with rises in temperature, producing high gas pressures. The volatile components in the fuel are necessary to provide easy starting of engines, especially in cold weather.

Gum. Gum formation is the most common form of deterioration occurring in fuels. Unsaturated hydrocarbons in fuels tend to undergo chemical changes in the presence of oxygen, first producing gummy materials and later resinous materials. The gummy materials remain dissolved in the fuel but are difficult to vaporize. The actual effect on engine performance has not been definitely established. Gum oxidation inhibitors are added to fuels, but these additives are effective for a limited time only and do not offer permanent protection. A certain amount of gum may be formed by the leaching of plasticizers from the tanks and hose of the AAFS/TAFDS. These gums are primarily of the stable soluble variety and are not likely to have any harmful effects on engines. This gum may be maintained within acceptable limits by recirculation.

Microbiological growth. This consists of living organisms which grow at the fuel/water interface. The organisms include protozoa, fungi, and bacteria; however, fungus is the major cause of most of the problems associated with microbiological contamination of jet fuels. Fungus is a vegetative life; it holds rust and water in suspension and is an effective stabilizing agent for fuel-water emulsion. It clings to glass and metal surfaces and can cause erroneous readings in fuel quality systems and sluggish fuel control operation. Microbiological growth is generally found wherever pockets of water exist in fuel tanks. It has a brown, black, or gray color and a stringy, fibrous like appearance. The presence of microbiological growth in fuel which is being delivered to aircraft is a reliable indication of failure of fuel filtration equipment, inadequate water stripping of storage tanks and/or a need for more frequent cleaning of storage tanks.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. Quality control is the responsibility of the

   a. company commander.
   b. platoon commander.
   c. platoon sergeant.
   d. bulk fuel man.

2. The greatest danger of products becoming mixed is in the

   a. hoses.
   b. collapsible tank.
   c. tanker truck.
   d. tanker compartments.

3. Gum may be maintained within acceptable limits by

a. filtering.
b. mixing.
c. purification.
d. recirculation.

Work Unit 3-3. FUEL STORAGE TECHNIQUES

COMPUTE TWO RECIRCULATION PERIODS.

IDENTIFY ONE OCCASION WHEN RECIRCULATION IS NECESSARY.

Petroleum products change their characteristics as they age and this change may be accelerated by storage conditions. The most common forms of deterioration are weathering, gum formation, and loss of additives. The only known feasible way to keep the fuel fresh and pure, to control existing gum and retard its further formation, is recirculation. Recirculation involves the transfer of fuel from one part of the system through every other part into an empty or partially filled tank. The possibility of contamination increases the longer a fuel lies dormant. If the fuel lies dormant in the system more than 24 hours, recirculation must be employed to control the existing gum formation. A good practice is to recirculate the fuel through the pumps and back into the tanks for about 15 minutes prior to daily operations. The filter-separator should be used whenever possible. Any recirculation method that pumps fuel through every installed component of the system is acceptable to reduce the gum factor. One method is described below as an example.

a. Typical recirculation method. With the valve nearest the dispensing nozzle stand closed, disconnect the nozzles from their respective discharge hose lines. Attach each hose line to a matching fitting on a drum unloading manifold. Attach one end of a hose to the connection on the drum unloading manifold. Attach the other end of the hose to the inlet side of a partially filled tank, and include any hose already attached to the inlet side of the tank. Operate the pump unit at approximately 150 gpm.

(1) Steps used to determine the required circulation time.

(a) Determine the total feet of the 4-inch hose installed.

(b) Determine the total feet of the 2-inch hose installed.

(c) Multiply the total feet of the 4-inch hose by 0.1 to determine the volume of fuel in the hose. Each cubic foot of hose will hold approximately 7.5 gallons of fuel.

(d) Multiply the total feet of the 2-inch hose by .05 to determine the volume of fuel in the hose.

(e) Add the results of steps (c) and (d) to obtain the volume of the installed hose.

(f) Multiply the results in step (e) by 7.5 to obtain the gallons of fuel in the hose line.

(g) Divide the gallons of fuel in the hose lines by 150-gpm flow rate to obtain the required pumping time in minutes.

(h) Multiply the pumping time, in minutes, by 2 to obtain the recommended recirculation time.

(2) Now, try a problem on recirculation using the above listed steps.

(a) 4-inch hose (12322 feet)

(b) 2-inch hose (320 feet)

(c) 4-inch hose X 0.1 = 1232.2

(d) 2-inch hose X 0.05 = 16.00

(e) 1232.2 + 16.00 = 1248.2

(f) 1248.2 X 7.5 = 9361.5

(g) 9361.5   150 = 62.4; round off to 62

(h) 62 X 2 + 124 minutes (For hours 124   60 = 2.06 or 2

Obviously, this is just a practice problem designed to take you through the steps and not for actual use since the actual amount that you would find is much smaller and the time greatly reduced. Try a few practice problems on your own.

> Disposition of unused fuel. Drain the fuel back into the tanks if it is unused. If weather conditions force aircraft to be grounded for at least 48 hours, drain the fuel in all of the dispensing hoses back into the tanks. If it is impossible to drain the lines, circulation should be carried out as outlined above.

b. Flushing the system prior to changing fuel types. When one type of fuel is to be removed from a system, the system should be flushed with the new fuel type prior to dispensing. Flushing the system requires pumping the flushing agent through every part of the assembled system. Thoroughness in this operation is very important, especially in the TAFDS. Water should not be used to flush a system except as a last resort.

Caution: If water is used, extreme caution must be exercised to insure that (1) the entire system is dry before using it for fuel; (2) the filter-separator and fuel monitor assemblies are disconnected before flushing; and (3) recirculation is employed and quality control checks are performed.

c. Reports. The operator of each pump unit used throughout the system should keep hourly pumping reports that include the time, pump station, designation, pump suction and discharge pressures, and engine rpms. It is mandatory that the beach unloading station install a fuel meter and make notation of this. Receipts should be reported to the officer in charge and a daily record maintained of the fuel received. The quantity of fuel in tanks can be roughly determined by using a tank capacity indicator. A daily record of the quantity on hand should be maintained at each of the tank farms. A check of the amount of fuel dispensed will normally be possible by recording meters. Daily records of dispensed fuel must be maintained whether it is packaged or bulk. All reports that are required will usually be prescribed by higher echelons.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. Compute the recirculation time for part of the bulk fuel farm using 1400 feet of a 4-inch line. What is the result?

   a. 12 minutes
   b. 14 minutes
   c. 16 minutes
   d. 20 minutes

2. Compute the recirculation time for part of the bulk fuel farm using 900 feet of a 2-inch line. The result is

   a. 2 minutes.
   b. 5 minutes.
   c. 6 minutes.
   d. 10 minutes.

3. When fuel lies dormant for a period of __________, recirculation must be employed to prevent gum buildup.

   a. 12 hours
   b. 24 hours
   c. 36 hours
   d. 48 hours

Work Unit 3-4. FUEL SAMPLING PROCEDURES

IDENTIFY TWO METHODS OF SAMPLING.

All personnel in the AAFS/TAFDS should be familiar with the methods used to take test samples of fuels for field and base laboratory testing. Correct procedures and clean sampling are essential if accurate results are to be obtained. The capabilities of the testing equipment and the proficiency of laboratory personnel vary from the crudest field methods to the best laboratories. Petroleum testing at bases and supply points is accomplished by highly skilled laboratory technicians with delicate and complex equipment under controlled conditions. You can be assured that the results obtained will be properly interpreted to meet the performance requirements of aircraft and other motorized equipment in the Marine Corps.

The importance of delivering fuels of adequate quality cannot be overemphasized. The responsibility of bulk fuel units is especially great when it becomes necessary to supply petroleum products under field conditions without the benefit of elaborate facilities. Every bulk fuel man can share the responsibility of maintaining quality in fuels by having a thorough understanding of the problems involved, the nature of fuels, and the limitations of organic equipment.

A true sample of the fuel being dispensed must be taken from the dispensing nozzles. The sample from the collapsible tanks may be taken from a drum thief, a plastic tube with holes in both ends. To take the sample, you must remove the relief valve and flame arrester from the top of the standpipe on the collapsible tank. Insert the drum thief through the standpipe hole to within 5 inches of the bottom of the tank. Then place your thumb over the hole at the tip of the thief, remove the sample and place it in a clean container, by placing the bottom end of the tube in the container and removing your thumb from the top, letting the fuel run out. To obtain a bottom sample, place your thumb over the hole in the top of the thief and lower it to the bottom of the tank. Remove your thumb to allow the drum thief to fill, then replace your thumb over the hole and remove the sample. The disadvantage of this method is the length of the drum thief which may not be long enough to reach the bottom of the tank.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. A true a sample of the fuel being dispersed must be taken from the

a. tank.
b. hoses.
c. filter-separator.
d. nozzle.

2. To take a sample from the collapsible tank, you should use the

a. plastic tube.
b. drum thief.
c. gage.
d. nozzle.

Work Unit 3-5. TESTS OF PETROLEUM SAMPLES

GIVEN FIVE TYPES OF FUELS AND FIVE SPECIFIC COLORS, MATCH EACH OF THE FIVE FUELS WITH ITS COLOR.

DEFINE SAMPLE.

IDENTIFY THREE CHARACTERISTICS OF API GRAVITY TESTING.

COMPUTE ONE API GRAVITY PROBLEM.

IDENTIFY TWO PRODUCT TESTS.

Since you will at times, have to test samples of products, you should know a little about the tests. Samples are important because they are used to determine the quality of petroleum products. A sample can be defined as a small amount of product which is representative of a whole quantity. When you take a sample, you must ensure that the sample used is clean and not contaminated with any previously tested product.

After samples have been taken, only simple tests can be made by an untrained man under field conditions. The tests normally made to fuels handled by AAFS/TAFDS are:

Appearance (color).
American Petroleum Institute (API) gravity and specific gravity by hydrometer.
Water and sediment (visual).

Laboratory Tests:

Distillation (low) of gasoline, naphtha, kerosene, and similar petroleum products.
Closed-cup flashpoint of fuel oils, lube oils, and other viscous products.
Copper dish gum in gasoline.
Copper corrosion by petroleum products.

Appearance test (color). Certain fuels used in military service are colored for identification purposes. A dye is used for color; however, it does not increase the octane of the fuel. Tables 3-1 and 3-2 give the color and octane performance number of some fuels. Darkening of jet fuels may indicate the formation of insoluble gum. If jet fuel is darker than the shipping papers indicate it should be, a sample should be taken and sent to a laboratory for an existent gum test. A sample should be taken at the dispensing nozzle to test the color of the fuel in the field. The sample should be in a glass container so that it may be readily seen.

Table 3-1. Aviation Fuel Colors

Color	Octane performance number
Colorless to straw	JP-4 and JP-5
Red	80/87
Blue	91/96
Green	100/130
Purple	115/145

Table 3-2. Motor Vehicle Fuel

Color	Octane performance number
Red	Combat MOGAS 91 octane
Colorless to straw	Diesel DRII cetane rated

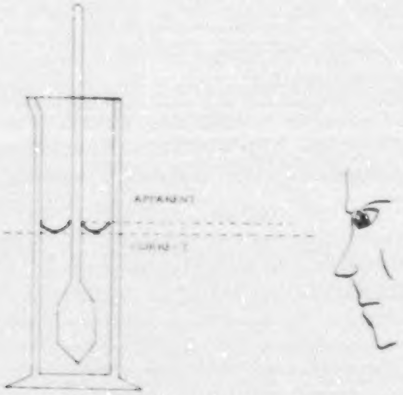


Fig 3-3. Correct method of reading hydrometer.

Table 3-3. API Gravity Readings
(Correct to 60° F)

Grade of fuel	API gravity
JP-4	45° to 57°
JP-5	36° to 48°
80/96	63.3° to 74.7°
91/96	63.3° to 72.4°
100/130	63.4° to 72.8°
115/145	67.1° to 72.5°

API gravity test. You will have to perform this test to determine the weight per unit volume of a petroleum product. This test is used for product control in the tank farm to determine total product weight and it also can show product contamination. Gravity is the weight per unit of volume. You must understand density also. This is the amount of weight or gravity exerted on matter in a given space. For instance, water has a density of one gram per cubic centimeter. Water is used as a standard for measuring the density or specific gravity of a substance. Since water is used as a standard, specific gravity is the ratio of a mass of a given volume of liquid at 60° F to the mass of an equal volume of pure water at the same temperature.

The formula for specific gravity is: $\frac{\text{Density of Product}}{\text{Density of Water}}$

Specific gravity will have no units because it is expressed as a ratio of densities.

Although API gravity is used for testing instead of specific gravity by the Marine Corps, it is helpful to know the difference between them. API stands for the American Petroleum Institute. This institution sets up a scale of gravity for petroleum products that is a little easier to work with than specific gravity.

50–59° API **API Gravity Reduction to 60° F.**

50–100° F.

Observed Temperature, °F.	API Gravity at Observed Temperature									
	50	51	52	53	54	55	56	57	58	59
	Corresponding API Gravity at 60° F.									
50	51.0	52.0	53.0	54.0	55.1	56.1	57.1	58.1	59.1	60.2
51	50.9	51.9	52.9	53.9	54.9	56.0	57.0	58.0	59.0	60.0
52	50.8	51.8	52.8	53.8	54.8	55.9	56.9	57.9	58.9	59.9
53	50.7	51.7	52.7	53.7	54.7	55.8	56.8	57.8	58.8	59.8
54	50.6	51.6	52.6	53.6	54.6	55.6	56.7	57.7	58.7	59.7
55	50.5	51.5	52.5	53.5	54.5	55.5	56.5	57.5	58.6	59.6
56	50.4	51.4	52.4	53.4	54.4	55.4	56.4	57.4	58.5	59.5
57	50.3	51.3	52.3	53.3	54.3	55.3	56.3	57.3	58.3	59.3
58	50.2	51.2	52.2	53.2	54.2	55.2	56.2	57.2	58.2	59.2
59	50.1	51.1	52.1	53.1	54.1	55.1	56.1	57.1	58.1	59.1
60	50.0	51.0	52.0	53.0	54.0	55.0	56.0	57.0	58.0	59.0
61	49.9	50.9	51.9	52.9	53.9	54.9	55.9	56.9	57.9	58.9
62	49.8	50.8	51.8	52.8	53.8	54.8	55.8	56.8	57.8	58.8
63	49.7	50.7	51.7	52.7	53.7	54.7	55.7	56.7	57.7	58.7
64	49.6	50.6	51.6	52.6	53.6	54.6	55.6	56.6	57.6	58.5
65	49.5	50.5	51.5	52.5	53.5	54.5	55.5	56.5	57.4	58.4
66	49.4	50.4	51.4	52.4	53.4	54.4	55.4	56.3	57.3	58.3
67	49.3	50.3	51.3	52.3	53.3	54.3	55.3	56.2	57.2	58.2
68	49.2	50.2	51.2	52.2	53.2	54.2	55.1	56.1	57.1	58.1
69	49.1	50.1	51.1	52.1	53.1	54.1	55.0	56.0	57.0	58.0
70	49.1	50.0	51.0	52.0	53.0	54.0	54.9	55.9	56.9	57.9
71	49.0	49.9	50.9	51.9	52.9	53.9	54.8	55.8	56.8	57.8
72	48.9	49.8	50.8	51.8	52.8	53.8	54.7	55.7	56.7	57.6
73	48.8	49.8	50.7	51.7	52.7	53.6	54.6	55.6	56.6	57.5
74	48.7	49.7	50.6	51.6	52.6	53.5	54.5	55.5	56.5	57.4
75	48.6	49.6	50.5	51.5	52.5	53.4	54.4	55.4	56.3	57.3
76	48.5	49.5	50.4	51.4	52.4	53.3	54.3	55.3	56.2	57.2
77	48.4	49.4	50.3	51.3	52.3	53.2	54.2	55.2	56.1	57.1
78	48.3	49.3	50.3	51.2	52.2	53.1	54.1	55.1	56.0	57.0
79	48.2	49.2	50.2	51.1	52.1	53.0	54.0	55.0	55.9	56.9
80	48.1	49.1	50.1	51.0	52.0	52.9	53.9	54.9	55.8	56.8
81	48.0	49.0	50.0	50.9	51.9	52.8	53.8	54.8	55.7	56.7
82	48.0	48.9	49.9	50.8	51.8	52.7	53.7	54.7	55.6	56.6
83	47.9	48.8	49.8	50.7	51.7	52.6	53.6	54.6	55.5	56.4
84	47.8	48.7	49.7	50.6	51.6	52.5	53.5	54.4	55.4	56.3
85	47.7	48.6	49.6	50.5	51.5	52.4	53.4	54.3	55.3	56.2
86	47.6	48.5	49.5	50.5	51.4	52.4	53.3	54.2	55.2	56.1
87	47.5	48.5	49.4	50.4	51.3	52.3	53.2	54.1	55.1	56.0
88	47.4	48.4	49.3	50.3	51.2	52.2	53.1	54.0	55.0	55.9
89	47.3	48.3	49.2	50.2	51.1	52.1	53.0	53.9	54.9	55.8
90	47.3	48.2	49.1	50.1	51.0	52.0	52.9	53.8	54.8	55.7
91	47.2	48.1	49.0	50.0	50.9	51.9	52.8	53.7	54.7	55.6
92	47.1	48.0	48.9	49.9	50.8	51.8	52.7	53.6	54.6	55.5
93	47.0	47.9	48.9	49.8	50.7	51.7	52.6	53.5	54.5	55.4
94	46.9	47.8	48.8	49.7	50.6	51.6	52.5	53.4	54.4	55.3
95	46.8	47.7	48.7	49.6	50.5	51.5	52.4	53.3	54.3	55.2
96	46.7	47.7	48.6	49.5	50.5	51.4	52.3	53.2	54.2	55.1
97	46.6	47.6	48.5	49.4	50.4	51.3	52.2	53.1	54.1	55.0
98	46.5	47.5	48.4	49.3	50.3	51.2	52.1	53.0	54.0	54.9
99	46.5	47.4	48.3	49.2	50.2	51.1	52.0	52.9	53.9	54.8
100	46.4	47.3	48.3	49.2	50.1	51.0	51.9	52.8	53.8	54.7

Table 3-4. API Gravity Reduction to 60° F.

Remember that the specific gravity of water at 60° F has a value of 1.0000. API gravity is also based upon water as a standard. Water has an API gravity of 10.00. The lighter the weight of the product, the higher the API gravity. This is an inverse relationship to the specific gravity scale. An API of 30.0 has a specific gravity of about .8770. An API of 60.0 has a specific gravity of about .7385. API gravity is measured with one decimal place while specific gravity uses four. API gravity is essentially much easier to work with. Table 3-4 shows some sample readings corrected to 60° F. API and the American Society for Testing and Materials (ASTM) have developed a table of values for converting API gravity, at any temperature, to a temperature of 60° F.

You have now learned about gravity, specific gravity, API gravity and density, and are now ready to perform the test.

To perform the API gravity test, dispense a fuel sample from the nozzle spout into a clean, tall beaker so that enough fluid is present to float the hydrometer. Use a 200-milliliter beaker. Fill the beaker to approximately 150 milliliters. Place a hydrometer, which has the proper scale for the fuel being tested, into the beaker. The hydrometer must NOT touch the sides of the beaker when the reading is being taken for the API gravity; if it does touch, you will get an incorrect API gravity reading. Figure 3-3 shows the correct method of reading the hydrometer. Table 3-3 lists some API gravity readings for some of the fuel systems. A change of gravity for the fuels in table 3-3 may indicate a change of composition caused by the mixing of grades of different products. A lower gravity reading indicates a heavier fuel. The variation in degrees of API gravity reading generally should not exceed 0.5 API gravity from previous API gravity test results for the individual fuel. Whenever you receive fuel, you will be given the API gravity reading for that particular fuel. If the 0.5 is exceeded, the sample should be checked with another hydrometer. If the limit still exceeds it, the fuel should not be used until adequate technical advice has been obtained.

In some units, the test will end at this point but in the event it does not, you will have to know the whole test. The rest of the test is as follows:

Most hydrometers will have a reverse scale on them so you can take the temperature of the fuel before and after the test. If the temperature varies more that .5 F, you should do the test over again.

Now that you have a degree reading and the API, you need to correct them to 60 F. You need to look at the table developed by the API and ASTM. This table is referred to as Table 5 and is found in FM-18 (Petroleum Terminal and Pipeline Operations) (Table 3-4), as well as in other manuals.

For example, assume a sample of JP-4 was tested. You took a sample and recorded an API of 51.6. The temperature of the fuel was 71° F. First, go to the observed API of 51.6 of Table 3-4. The API gravity at observed temperatures is printed in whole numbers API degrees. This means you must figure the corrected API of two API's, one on each side of 51.6 and both at 71 F. For instance, say that the following is what you found in Table 5:

	Observed API	Corrected API
71° F	51	49.9
71° F	52	50.9

Now, going a little further, you observed API at 71° F in the right place ----

	Observed API		Corrected API
@71° F	51.0 51.6 52.0	@60° F	49.9 x your corrected API 50.9

Now what?! You must find the value for x. This process is called interpolation. Let's see how it is done:

$$\text{difference of extremes} \longleftarrow \left[\begin{array}{l} 51.0 \\ 51.6 \\ 52.0 \end{array}\right. \quad \left.\begin{array}{l} 51.0 \\ 51.6 \end{array}\right] \longrightarrow \text{difference of means} \longleftarrow \left[\begin{array}{c} 49.9 \\ x \\ 50.9 \end{array}\right] \longrightarrow \text{difference of extremes}$$

Here is the equation:

$$\frac{\text{Means}}{\text{extremes}} = \frac{\text{means}}{\text{extremes}}$$

By substituting in the equation from your table of values you will find:

$$1.0 \left[\begin{array}{l} 51.0 \\ 51.6 \\ 52.0 \end{array}\right. \quad \left.\begin{array}{l} 51.0 \\ 51.6 \end{array}\right] 0.6 \qquad x \left[\begin{array}{c} 49.9 \\ x \\ 50.9 \end{array}\right] 1.0$$

Therefore: $\frac{0.6}{1.0} = \frac{x}{1.0}$

How do we find x? Easy!!

$\frac{0.6}{1.0} = \frac{x}{1.0}$ By crossing multiplying.

$\frac{1.0}{x} = \frac{1.0}{0.6}$ You then have:

$1.0X = 0.6X1.0$ This equals: $\begin{array}{r} 1.0 \\ \times 0.6 \\ \hline .60 \end{array}$

Now solve for x: $1.0x = 0.6$ and $\frac{1.0x}{1.0} = \frac{0.6}{1.0}$

So then: $\frac{\cancel{1.0}x}{\cancel{1.0}_1} = \frac{0.6}{1.0}$ $x = 0.6$

Now add 0.6 to 49.9. Your corrected API @60° F is 50.5!

Visual (sediment) test. The visual or appearance test sample is obtained from the nozzle spout at the point where dispensing operations are carried on. The sample should be taken in a clear beaker. Observe the sample for sediment and water. If there is water in the sample, the sample will appear cloudy. The sediment will settle to the bottom of the beaker after the sample has been standing for about 30 minutes. If either water or sediment is present, a sample should be taken and sent to the laboratory for testing. Free water may be removed from the collapsible tanks. Check the filter-separator also.

Distillation (low). Distillation generally involves vaporizing the fuel sample in a suitable flask and noting the temperature of the distillation flask and the amount of distillate at certain intervals. The initial boiling point and 10% point indicate the ignition quality of the fuel; the 50% point indicates the warmup time and smoothness with which the engine will operate after warmup. A high 90% point and end point accompanied by a heavy residue indicate possible contamination by a heavier product. When the test is conducted, a draft-free, ventilated area with moderate ambient temperatures is required. The heat source must be variable but free from fluctuations. The constant-temperature bath for the condensing coil requires a source of ice. These conditions are often difficult to duplicate in the field, and the test is of little value unless it is conducted and interpreted by experienced personnel.

Closed-cup flashpoint. The sample is placed in the cup of the tester and, with the lid closed, is stirred slowly as the temperature is increased at a specified rate. A small flame of a specified size is directed into the cup at regular temperature intervals; the lowest temperature at which the flame causes a distinct flash in the interior of the cup is the flashpoint. This test is applicable to JP-5 and diesel fuels only. A substantially lower flashpoint than expected for the product is a reliable indication that the product has been contaminated with a more volatile product such as gasoline. The flashpoint is also an aid in identifying a particular petroleum product.

Copper dish gum. This test applies to aviation gasolines only. The sample is evaporated from a clean, dry, highly polished copper dish placed in a constant temperature steam bath with a gentle uniform flow of air to remove vapors. After the volatile material has been evaporated, the dish is placed in an electric oven for 30 minutes. The residue is expressed as milligrams per 100 milliliters of the sample and reported as copper dish gum. In practice, it is difficult to standardize the test conditions sufficiently to control the catalytic reactions for closely reproducible results.

Copper corrosion by petroleum products. A polished strip is immersed in the fuel sample in a chemically clean test tube. The tube is then placed in a temperature bath. The bath temperature and immersion time are functions of the fuel under test. The strip is then examined for evidence of corrosion and assigned a rating number in accordance with the ASTM Copper Corrosion Standards scale. The copper-strip corrosion test does indicate the total sulfur compounds present in a test sample and whether the corrosive compounds are present. Corrosive compounds may be present because of improper refining or contamination from other sources. This type of contamination is not likely to be encountered by the expeditionary force.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

Matching: Column 1 (items 1-5) contains five types of octane or cetane performance numbers. Column 2 (a through e) contains five specific colors. Match each type of fuel or octane performance number in column 1 with its specific color in column 2. Place your answers in the spaces provided to the left of the column 1.

Column 1 Octane or Cetane performance number	Column 2 Color
____ 1. DR 11	a. Colorless to straw colored
____ 2. 91/96	b. Red
____ 3. 115/145	c. Blue
____ 4. 100/130	d. Green
____ 5. MoGas	e. Purple

6. Define sample. ______________________________
____

7. The API gravity reading of 45° to 57° applies to

a. 80/96.
b. 91/96.
c. JP-4.
d. 115/145.

8. "Table 5" refers to API and ASTM values which are correctable to

a. 30°.
b. 60°.
c. 45°.
d. 75°.

9. When you receive fuel, the API gravity should not exceed

a. .1.
b. .05.
c. .5.
d. .15.

10. You have an observed temperature of 55 and an API of 55.5, so the corrected API is __________ (use table 3-4).

a. 56.0
b. 57.7
c. 52.0
d. 52.1

11. The test that applies to aviation gas only is called the

a. closed up flashpoint test.
b. copper dish gum test.
c. copper corrosion test.
d. distillation test.

12. What test shows sediment and water in the product using only a clear beaker?

a. Distillator test
b. Copper dish gum test
c. Visual or appearance test
d. Copper corrosion test

SUMMARY REVIEW

Now that you have learned the proper fuel handling procedures, you can also identify fuel transfer methods, quality control procedures, and fuel coupling procedures, all of which comprise the proper ways to handle fuel. You have also learned how bulk fuel is stored.

Answers to Study Unit #3 Exercises

Work Unit 3-1.

1. a. floating-line
   b. bottom-laid
2. a. downgrading
   b. blending
   c. purification
   d. dehydration
3. a. on roads
   b. burned
   c. buried
   d. transferred
   e. mixed

Work Unit 3-2.

1. d.
2. d.
3. d.

Work Unit 3-3.

1. b.
2. b.
3. b.

Work Unit 4-4.

1. d.
2. b.

Work Unit 3-5.

1. a.
2. c.
3. e.
4. d.
5. b.
6. A sample is a small amount of product which is representative of a whole quantity
7. c.
8. b.
9. c.
10. a.
11. b.
12. c.

STUDY UNIT 4

SAFETY AND FIREFIGHTING EQUIPMENT AND PROCEDURES

STUDY UNIT OBJECTIVE: WITHOUT THE AID OF REFERENCES, YOU WILL IDENTIFY SAFETY AND FIREFIGHTING GUIDELINES. YOU WILL IDENTIFY FIREFIGHTING EQUIPMENT AND BOTH PREVENTIVE MAINTENANCE AND TROUBLE-SHOOTING PROCEDURES. YOU WILL ALSO IDENTIFY THE LIMITATIONS AND CAPABILITIES OF FIREFIGHTING EQUIPMENT.

Work Unit 4-1. SAFETY GUIDELINES FOR BULK FUEL

IDENTIFY THE HEALTH HAZARDS OF WORKING WITH PETROLEUM.

IDENTIFY TWO FORMS OF FIRST AID FOR HEALTH HAZARDS.

IDENTIFY THREE GUIDELINES FOR SAFETY AROUND PETROLEUM.

You are responsible for safety in the fuel farm. At times, it seems everyone wants to know how a mishap was caused or how it could have been prevented. The dangers in the fuel farm are not limited to fires although that is the most obvious danger. The fuel itself can be hazardous to your health as well as to those around you. There are so many hazards in the fuel farm that every Marine employed there is in charge of safety.

a. Health hazards (dealing with fuel)

(1) Inside the Body. Flammable liquid products are dangerous if you get them in your mouth and they may be fatal if you swallow them. If someone does swallow a petroleum product, the following first aid measures must be taken:

(a) Keep the victim calm. (Note: DO NOT induce vomiting, which would further irritate the casualty's throat.)

(b) Give victim 1/2 canteen of water or 1 pint of milk, which will dilute the fuel.

(c) Get immediate medical aid for the victim.

(2) In the Eyes. Flammable liquids can be extremely irritating to the eyes and can cause severe eye damage. If someone's eyes have come in contact with petroleum fuels, the following first aid measures must be taken:

(a) Flush the victim's eyes for at least 10 minutes with water.

(b) Cover both eyes with dressing material or clean cloth as available.

(c) Get immediate medical aid for the victim.

(d) Keep the victim calm.

(3) On the Skin. Flammable liquid petroleum also causes skin contamination. The seriousness of skin contamination ranges widely, depending upon the substance. The most serious effects result from contact with strong acids, alkalis, and rocket fuels. Effects from gasoline, jet fuel and solvents, paints, lacquers and varnishes act on the skin to dry up natural fats and oils. This leaves the skin harsh, dry, and chapped, resulting in a condition known as dermatitis. These unnatural skin openings or lesions increase your chances of infection. If you get petroleum on your skin, wash it off at once with soap and water. If your clothes are soaked with fuel, wet them with water before you take them off. If you don't have any water, temporarily ground yourself by taking hold of a piece of grounded equipment with one hand. Then take off your clothes. This grounding protects you from the danger of a static spark igniting your clothes as you remove them. After clothing is removed, wash the skin with soapy water, rinse with fresh water and get medical aid.

b. Gases and vapors. The terms "gas" and "vapor" are often used to mean the same thing, although there is a difference. A gas exists as a gas at ordinary temperature and pressure. A vapor is a gas-like form of a substance that is ordinarily a solid or liquid. Gases and vapors are divided into four groups depending on whether they are poisonous (toxic), asphyxiants, anesthetics, or irritants. Remember that each substance usually has more than one property. For example, it can be anesthetic and also toxic.

(1) Poisons. Poisonous or toxic gases and vapors have various effects on the body. They may injure or destroy the internal organs, the blood-forming system, tissues, or bones. Toxic effects often show up only after a prolonged exposure. The most poisonous gas or vapor is hydrogen sulfide found in crude oil of high sulfur content or tetraethyl lead vapor from leaded gasoline. You must avoid exposure to them at all times, because they can kill you. Victims of hydrogen sulfide may fall unconscious upon exposure and never regain consciousness. Other gases, listed in the order of toxicity, are refrigerants like sulfur dioxide, ammonia, methyl bromide, butane, propane, and the freons.

(2) Asphyxiants. Simple asphyxiants are gases and vapors that keep the lungs from getting oxygen. In other words, they replace the oxygen that is in the air. Some of them are methane and its related hydrocarbons, hydrogen, and acetylene which are used in welding and flamecutting. A chemical asphyxiant, like carbon monoxide gas, acts upon the blood in such a way that is is unable to absorb enough oxygen to sustain the organs of the body. This causes the organs to fail due to lack of oxygen.

(3) Anesthetics. Anesthetic gases and vapors have a narcotic effect, depressing the central nervous system to the point where respiratory failure may occur. All hydrocarbon vapors have this effect. The most narcotic are acetone, the ethers, benzene, naphthas, gasolines, and jet fuels. Others are hydrocarbon derivatives that contain members of the chlorine family. Exposure to burning hydrocarbon vapors can cause tremor of the heart ventricles. Narcotic effects of gasoline and jet fuel increase with aromatic content.

(4) Irritants. Irritant gases and vapors inflame the lungs and respiratory tract. They may cause pneumonia and other pulmonary diseases or make the victim more susceptible to them. Most flammable gases and vapors are irritants whether they are poisonous or narcotic.

(5) First Aid for Vapor Inhalation. Inhalation (breathing) of petroleum products can cause dizziness, nausea and headaches; large amounts may cause unconsciousness. When working around petroleum products, if a person should get dizzy, nauseous or develop a headache, remove him/her from the area immediately. For the unconscious victim, remove him from the danger area and give artificial respiration; call a physician.

c. General safety precautions. The following general precautions are related to fuel systems and fuel handling. Although they may not be explicitly set forth in this course, they are implied. These precautions should be understood and followed to prevent accidents, bodily injury, or damage to equipment.

(1) Prohibit smoking except in designated areas. Prohibit matches and lighters in hazardous areas.

(2) Never use fuel to wash the hands.

(3) Avoid getting fuel on the skin; wash fuel from the skin as soon as possible with soap and water.

(4) If fuel gets into the eyes or mouth, flush thoroughly with water (avoid swallowing), and get medical aid immediately.

(5) If fuel gets on clothing, remove clothing promptly but carefully, wash the skin, and replace clothes with clean items.

(6) Do not wear shoes with exposed nails, metal plates, or hobnails.

(7) Do not carry or wear exposed metal objects, such as knives, keys, or loose identification bracelets that could cause sparks if struck or dropped.

(8) Wear nonstatic-producing clothing, with shirts sleeves rolled down and buttoned.

(9) Do not carry or wear loose items of clothing.

(10) Keep shirt pockets empty.

(11) Wear leather gloves and all-leather, rubber-soled boots for splash protection.

(12) Use ear-protective devices near operating aircraft engines or other high-noise sources.

(13) Wear goggles or protective helmet with a visor for eye protection when fueling aircraft.

(14) Never use liquid fuels as cleaning fluids for floors, equipment, clothing, etc.

(15) Fuel vapors are heavier than air and will collect in low places such as pits or sumps; be especially careful in such areas.

(16) Open drums slowly, especially if they have been shaken or exposed to heat, to prevent a fuel-air mixture from spewing out.

(17) Beware of empty (or apparently empty) cans, drums, tanks, and hoses that formerly held fuel. Vapors can remain long after the container has been emptied, and the fuel-air mixture is more dangerous if ignited than the liquid alone.

(18) Dispose of oily waste or rags immediately after using by placing them in a self-closing metal container.

(19) Avoid spilling fuel; clean up spills at once if they happen. Wipe up small spills or cover with dirt. Follow local emergency procedures for large spills. Treat the area as dangerous until the vapors have gone.

(20) Keep all fuel containers, whether full or empty, tightly closed except when in use.

(21) Report leaks to the proper authorities. Do not operate leaky equipment.

(22) Do not conduct fuel handling operations in a hangar, shop, or other confined area.

(23) Allow at least 150 feet between bulk tank outlets and fuel dispensing points for fire safety.

(24) Use only flashlights, drop lights, or lanterns approved for use in hazardous locations.

(25) Use only explosion-proof electrical equipment and fixtures in hazardous areas; inspect often and correct any conditions that could cause sparking, arcing, or overheating.

(26) Open switches and pull fuses before doing essential work on electrical equipment.

(27) Equipment requiring welding and cutting operations must be clean and vapor-free; heaters, welding torches, or blowtorches must not be used within 50 feet of fuel handling operations.

(28) Stop all fuel handling operations during electrical storms.

(29) Bonds and grounds should be tested frequently to ensure conductivity; repair or replace defective parts. Bonds and grounds must be made before fuel flow begins, and must not be broken until flow ends.

(30) Vehicles carrying fuel as cargo and those operating within 50 feet of fuel handling operations must be equipped with spark-arresting exhaust system.

(31) Protective earthworks (berms) around collapsible tanks should be built to give the least possible exposed fuel surface in case of tank rupture. A small area generates the least vapor, and provides the smallest burning surface in case of fire.

(32) Do not pump fuel at a rate which will cause severe turbulence.

(33) Do not splash-fill tank or tank cars if top-loading is necessary. Start to fill at a slow rate with the filling hose near the tank bottom. When the hose end is submerged, loading can proceed at a full flow rate.

(34) Do not filter fuel through anything other than properly grounded filter-separators and monitors.

(35) After filling large tanks, allow several minutes of relaxation time to allow the static charge of the fuel surface to equalize with the tank before inserting gages or any other objects into the fuel.

(36) Do not throw or drag hoses and nozzles; avoid kinking hoses.

(37) Turn off aircraft radio and radar equipment during fueling or defueling.

(38) Do not conduct fueling operations within 300 feet of active ground radars.

(39) Aircraft to be refueled or defueled must be de-armed and must not have hot brakes.

(40) Do not clip ground wires to antennas, rotor blades, or propeller blades.

(41) Keep clear of rotor blades, propeller blades, and their paths.

(42) Keep the refueling area clear of loose material that could be blown about by prop wash, jet blast, or rotor wash.

(43) Tankers used to accept fuel removed from vehicles or aircraft will be plainly marked DEFUELER. A vehicle marked REFUELER will not be used to remove fuel from a using vehicle unless it is specifically authorized, nor will a vehicle marked DEFUELER be used to fuel vehicles.

(44) At least two persons are required in defueling operations.

(45) Refueling/defueling areas must be free of all possible ignition sources.

(46) In defueling, the defueler operator must check with the unloader (crew chief, plane captain, lineman, etc.) to be sure that the correct aircraft is being unloaded, all electrical equipment is off, and no repair work is being done.

(47) Firefighting equipment, including protective clothing, must be in good condition and readily available.

(48) Water alone should not be used on fuel fires since it tends to spread the fire.

(49) Fire extinguishing equipment must be in place and ready during refueling/defueling, including crash crew standby assistance if available.

(50) Drip pans should be maintained and not allowed to overflow.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. Gases and vapors are divided up into four groups depending on whether or not they are poisonous, asphyxiants, anesthetics, or

   a. flammables.
   b. irritants.
   c. toxic.
   d. infective.

2. When working around petroleum products, if a person should get dizzy, nauseous, or develop a headache, you should remove him/her from the area immediately. This is first aid for

   a. vapor inhalation.
   b. swallowing fuel.
   c. burns.
   d. fuel in the eyes.

3. If a person has swallowed flammable liquids, you should keep him calm, give him 1/2 canteen of water or milk to dilute fuel, and

   a. induce vomiting.
   b. get medical aid.
   c. loosen his clothing.
   d. flush his skin with water.

4. When you are working around operating aircraft engines, you should wear protective clothing to include

   a. polished boots.
   b. cloth gloves.
   c. nylon coveralls.
   d. hearing protection.

5. When you are working in the fuel farm with electrical equipment, you should ensure that the equipment is

a. shock-proof.
b. clean.
c. explosion proof.
d. 150 feet from tanks.

6. When you are involved in defueling operations, at least _____ persons are required.

a. 2
b. 3
c. 4
d. 5

Work Unit 4-2. FIRE PREVENTION

IDENTIFY ONE SOURCE OF FIRES.

IDENTIFY ONE CHARACTERISTIC OF A FIRE.

MATCH EACH CLASS OF FIRE WITH THE TYPE OF FIRE.

You have to know fire prevention and the hazards involved in handling petroleum when you work in the fuel farm. If you don't, not only can you cause great property damage, but there is also the possibility of injuries and loss of life. Therefore, before you can understand fire prevention, you must understand fire.

All fires connected with flammable products result from the ignition of vapors. There is little danger of fire in a closed container that holds a flammable product unless it is exposed to heat. The hazard arises from the ignition of vapors produced in use, transfer, leaks, and spills. The best way to prevent product fires is to minimize the buildup of vapors and to control the sources of ignition.

a. Smoking and Matches. Smoking and matches are the greatest single cause of common fires. You can greatly reduce the chance of fires by keeping smoking material out of the product area. Signs are posted in these areas such as "NO SMOKING WITHIN 50 FEET" or" NO SMOKING WITHIN 100 FEET". You, as the bulk fuel man, must follow these rules and you must also take the unit initiative to see that other Marines do likewise.

b. Housekeeping. Rubbish, garbage, and similar housekeeping problems are easily eliminated, yet they continue to cause fires. These sources can ignite with contact by small sources of heat, such as a cigarette or match. Garbage cans that are made of metal, should be provided with a cover and be emptied each day. You should not burn rubbish in them. Grass and weeds should be placed in garbage cans because as they dry out, they can be easily ignited.

c. Mechanical or Friction Sparks. Sparks caused by contact or friction between metal surfaces can ignite a fire. Grinding work should be done outside the fuel farm, but when this is not possible, you must be alert for the possibility of a fire. Most of the bulk fuel equipment will not cause a spark due to the aluminum alloy characteristics but tools that are not spark resistant will contribute to the fire potential.

d. Electrical Equipment. Electrical equipment becomes a fire hazard when it arcs, sparks, or overheats. When a current is interrupted, as in a circuit breaker, it produces an electric arc of very high temperature. Rotating parts of motors, generators and similar equipment produce arcs and sparks where the brushes contact the comutators. Worn wiring can produce an ignition source in two ways: by creating a short circuit and by allowing a buildup of heat to have oxygen contact. The electrical equipment used in the fuel farm should be explosion proof to minimize this hazard.

e. Static Electricity. Friction causes static electricity. For instance, bringing together and separating two unlike substances and almost any motion of personnel and material can produce it. Static electricity is also generated by the flow of flammable products. You cannot prevent static electricity; however, it only becomes a hazard if it is allowed to buildup and cause a spark. You can prevent sparks by bonding and grounding. Bonding is an electrical connection (a bonding wire) between metallic equipment and containers. This equalizes the electrical potential. Grounding is an electrical connection between one or both of the bonded transfer units and the ground. This dissipates electrical potential. When units of equipment are properly bonded and grounded, static electricity is transferred from the equipment and into the ground.

Fire is a combustion among three things: fuel, heat, and oxygen. If you eliminate one of these three things, the fire will either become smaller or go out. Fire extinguishers work on this principle. There are four classes of fires. These are:

Class A - consists of ordinary combustibles such as wood, paper, grass, and cloth.

Class B - involves flammable liquids such a gasoline, solvents, and paints.

Class C - involves live electrical equipment such as motors, switches, and transfers.

Class D - involves burnable metal and chemicals such as sodium and magnesium.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study.

1. The greatest single cause of common fires is

   a. static electricity.
   b. smoking and matches.
   c. housekeeping.
   d. electrical equipment.

2. A fire is a combustion among three things: fuel, heat, and

   a. gasoline.
   b. chemicals.
   c. igniting action.
   d. oxygen.

Matching: Column 1 (items 3-6) contains the four classes of fires. Column 2 (a through d) contains the various types of fires. Match each class of fire in column 1 with its type of fire in column 2. Place your answers in the spaces provided.

	Column 1 Classes of Fires	Column 2 Types of Fires
_____	3. Class A	a. Burning steel wool
_____	4. Class B	b. Burning transformer
_____	5. Class C	c. Wood fire
_____	6. Class D	d. Gasoline fire

Work Unit 4-3. FIREFIGHTING TRUCK MC1051

IDENTIFY TWO CAPABILITIES OF THE FIREFIGHTING TRUCK.

IDENTIFY ONE FEATURE OF THE CONTROLS ON THE FIREFIGHTING TRUCK.

STATE THE AGENT AND CHEMICAL COMPOSITION OF THE AGENT USED IN THE FIREFIGHTING TRUCK.

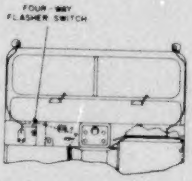
Firefighting truck, MC1051. The MC1051 firefighting truck (fig 4-1) is used to comba fires in fuel system installations. It is a dry chemical firefighting vehicle that uses "purple K" powder, a dry potassium chemical, which is delivered under pressure by means of two 50-foot hoses at a range of 35 feet beyond the nozzle. Two hand-portable dry chemical fire extinguishers are also carried in brackets located on the front bumper. They can be used to supplement the chemical flow from the hoses. When fully charged with 500 pounds of "purple K" powder and a 2,265-psi nitrogen cylinder to provide the gas pressure, the equipment will deliver the chemical agent through both hose nozzles for a period of 86 to 104 seconds, until the 500 pounds of dry chemical is exhausted.

Fig 4-1. Firefighting truck MC1051.

Operation and maintenance of firefighting truck MC1051

a. Controls and instruments. Locations and functions of the controls and instruments are shown in figures 4-2 and 4-3.

b. Before use. Before driving the vehicle to the fire area, pull out the 4-way flasher switch (fig 4-2). The 4-way flasher switch, added to the turn signal circuit of the vehicle, flashes all four turn signal lamps simultaneously as a hazard warning. Determine that the nitrogen cylinder pressure gage (2, fig 4-3) reads between 1,500 and 2,265 psi and that the chemical agent tank pressure gage (1, fig 4-3) reads 230, plus or minus 10 psi. If neither gage reads properly, determine that the nitrogen cylinder valve behind the passenger seat is open. Remove the lead-wire and locking pins from all valve and cock handles.



The 4-way flasher switch causes turn signal lamps to flash or blink if pulled out when turn signal switch is operated.

Fig 4-2. Dashboard control.

c. During use. (Note: Item numbers in (a) through (d) below refer to figure 4-3.) Upon arrival at the fire area, proceed as follows:

(1) Insure that both cleanout valves (5 and 8) are closed.

(2) Open the red tank valve (6).

(3) Open both hose cabinet doors and uncoil both hoses, laying them out on the ground.

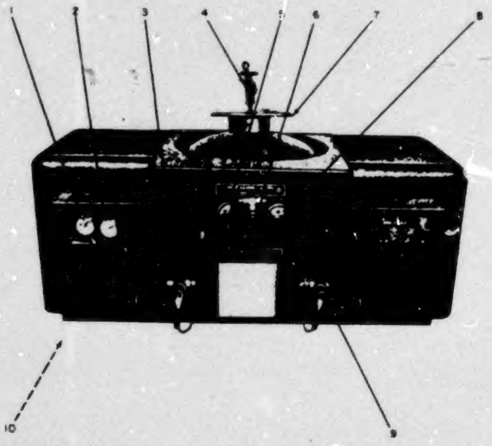
> Warning: Restrain both hoses from movement before they are pressurized or they will whip dangerously.

(4) Open both cock valves (3 and 9) by placing the handles in a horizontal position.

(5) Open the hose nozzles and direct the chemical stream at the base of the flames.

Note: The hand portable fire extinguishers, mounted on the front of the vehicle, can be used to supplement the chemical streams.

(6) Close the hose nozzles after the fire has been extinguished.



	Control or instrument	Function
1.	Chemical tank pressure gage	Indicates chemical tank pressure psi.
2.	Nitrogen cylinder pressure gage	Indicates nitrogen cylinder pressure in psi.
3.	Left-hand cock valve	Charges hose on passenger's side of truck.
4.	Vent valve (blue)	Vents chemical tank pressure.
5.	Left-hand hose cleanout valve	Applies nitrogen from cylinder to left-hand hose for chemical cleanout, when tank and cock valve are closed.
6.	Tank valve (red)	Applies pressure to contents of chemical tank.
7.	Tank fill cap	Closes fill hole of chemical tank.
8.	Right-hand hose cleanout valve	Applies nitrogen from cylinder to right-hand hose for chemical cleanout when tank and cock valve are closed.
9.	Right-hand cock valve	Charges hose on driver's side of truck.
10.	Nitrogen cylinder valve	Controls flow of nitrogen through micron filter to regulator.

Fig 4-3. Chemical tank controls and instruments.

d. After use. (Note: Item numbers in (1) through (11) below refer to figure 4-3.) Before storing the hoses, proceed as follows:

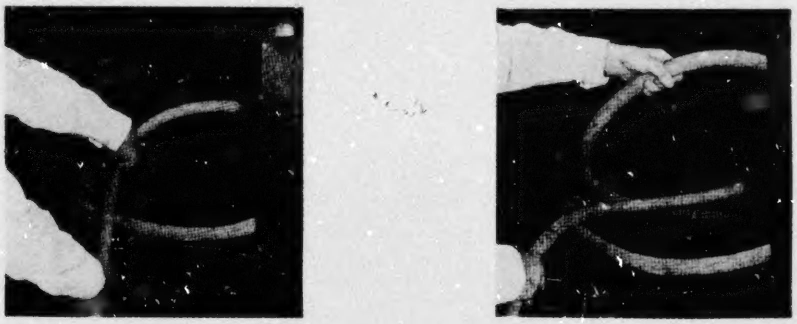
(1) Close the cock valves and tank valve (3, 9, and 6, respectively).

(2) Open both hose cleanout valves (5 and 8).

(3) Open each hose nozzle and keep it open until all the chemical is exhausted from the hose, then close.

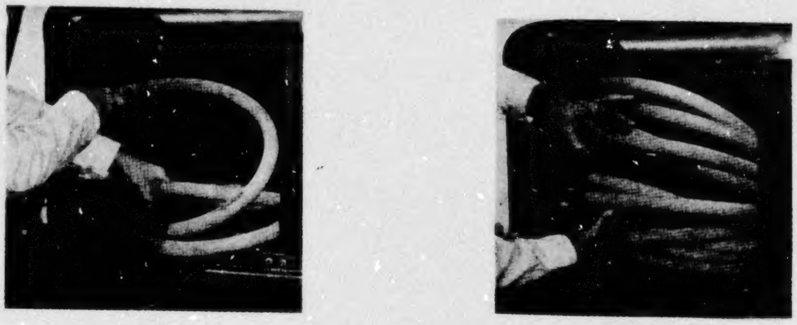
(4) Close both cleanout valves (5 and 8).

(5) Coil and store the hoses in the respective hose cabinets as shown in figure 4-4.



1. Loop hose as shown. Make it fit inside the cabinet so the door can be closed.

2. A reverse loop follows the first. Notice that the hose passes beneath the loop to make the reverse loop.



3. Alternate loops are reverse loops. Follow steps one and two until all the hose is coiled in the cabinet.

4. Notice the "over and under" position of the hose. Hose coiled in this manner will pull out free of twists.

Fig 4-4. Hose coiling method.

(6) Check to see that the nitrogen cylinder pressure gage (2) reads more than 1,500 psi. If the desired indication is not obtained, replace the nitrogen cylinder.

(7) Close the nigrogen cylinder valve.

(8) Open the blue vent valve (4) to release the chemical tank pressure; then close it.

(9) Remove the tank fill cap (7) and determine whether the chemical tank requires refilling. Fill the tank after every use with "purple K" powder. Replace the fill cap and tighten with both hands.

(10) Replace the locking pin and the lead wire seal on each of the six valves (3, 4, 5, 6, 8, and 9).

(11) Place the turn signal switch in the OFF position and push in the 4-way flasher switch.

(12) Before leaving the vehicle, flush all exterior surfaces with clear water to remove the splashed chemical fire-extinguishing agent (purple K).

(13) Reduce or eliminate operating hazards by observing the following:

(a) Before removing the tank fill cap, the tank and line must be thoroughly vented and all valves must be closed. As a safety device, the fill cap is constructed to allow venting of any tank pressure before the cap is fully unthreaded. This prevents a violent premature removal after the final thread is turned clear. Funnel 500 pounds of dry chemical firefighting agent (purple K) into the chemical tank and replace the cap tightly.

(b) When removing the chemical tank fill cap, stop the unthreading operation if any venting or pressure (clearly audible) is noted, until the inner and outer pressures are equalized. Close all valves and secure all but the nitrogen cylinder outlet valve with locking pins to prevent accidental actuation.

(c) Never discharge the chemical in an enclosed area, except for fighting a fire. The spray of dry chemical covers a wide area and the stream broadens at its maximum reach to approximately 15 feet. Caution as to where the spray will settle must be exercised.

(d) Never refill indoors, except as an emergency operation.

(e) Operator's daily preventive maintenance. Table 4-1 lists the operator's preventive maintenance checks that should be performed daily.

Table 4-1. Operator's Daily Preventive Maintenance Checks

What to check	How to check	Correct observation and corrective action
a. General appearance	1. Visually inspect the MC 1051 for evidence of damage, tampering, or missing parts. 2. Visually inspect the MC 1051 for dirt and grease.	1. No evidence of damage tampering, or missing parts. Repair damage or tampering; replace missing parts. 2. No dirt or grease present. If dirt or grease is found, remove it.
b. Valve wheels and cock valve handles	Inspect all six valves for locking pins secured by leadwire seals.	All valves secured with locking pins and leadwire seals. Secured valves.
c. Piping, joints, unions and valves	Visually inspect piping, joints, unions, and valves for signs of damage or leakage.	No evidence of damage or leakage. Repair damage or correct leakage.
d. Hose cabinet doors	Open and close hose cabinet doors.	Doors open and close freely and without interference. Door latches and hinges operate freely. Oil hinges and latches.
e. Hose	Inspect for kinks, porosity, dirt, grease, or sharp bends.	Hoses are not kinked, do not show porosity, are free from dirt or grease, and have no sharp bends. If necessary, replace hoses.
f. Hose nozzles	Operate nozzle valves.	Nozzle valves operate freely. Clean nozzle valves.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. When fully charged with nitrogen and purple "K" powder, the firefighting truck will deliver the chemical agent through the hoses for a period of

a. 2 to 4 minutes.
b. 60 to 90 seconds.
c. 86 to 104 seconds.
d. 1 to 3 minutes.

2. On the tank portion of the truck, the vent valve should be color coded blue and the tank valve should be colored coded

a. red.
b. orange.
c. yellow.
d. white.

3. The effective range of the firefighting truck is about ______________________ feet.

a. 50
b. 35
c. 25
d. 15

4. What agent is used in the firefighting truck and what is its chemical composition?

____

____

Work Unit 4-4. FIRE EXTINGUISHERS AND MAINTENANCE

IDENTIFY ONE OPERATING CHARACTERISTIC OF THE 30-POUND FIRE EXTINGUISHER.

IDENTIFY ONE STEP IN PREVENTIVE MAINTENANCE ON THE 30-POUND FIRE EXTINGUISHER.

IDENTIFY TWO OPERATING CHARACTERISTICS OF THE 150-POUND FIRE EXTINGUISHER.

In the event that you have to fight a fire, it is critical that you know what you are doing. If a tank or even a small pool of product is ignited, you must take immediate measures to extinguish it. Water is almost never used on a product fire since it tends to spread the fire.

Generally, the 30-lb extinguisher will be of the dry powder type, but at times, it may contain carbon dioxide (CO2). The 30-lb extinguisher should be used on smaller fires such a truck or engine fire on the pumping units. It has a range of 17 feet in a fan-shaped pattern with an 8-12 second operation (fig 4-5).

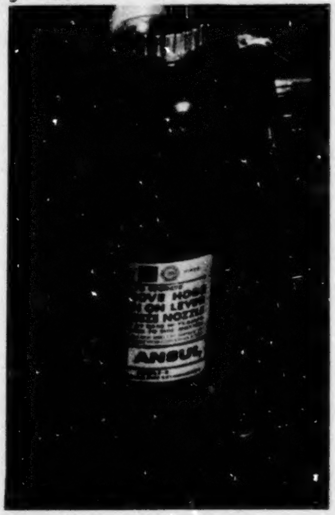


Fig 4-5. 30-lb fire extinguisher.

a. Operator's general maintenance. Any discrepancies noted when performing daily operator's maintenance should be reported immediately. Maintenance consists of the following:

(1) Note the general appearance for mechanical damage, missing components, and corrosion.

(2) Check the lead and wire seal at the nitrogen cylinder valve. Absence of a seal may indicate an unreported operation of the extinguisher.

(3) Read the pressure on the nitrogen cylinder valve gage; replace if necessary.

(4) Inspect the condition of the hose coupling and hose. Check the tightness of the hose couplings. Check the hose for obstructions.

(5) Remove the nozzle from the nozzle holder and examine the opening for obstructions.

(6) Hold the nozzle in one hand and operate the nozzle handle to check free movement. Close the nozzle and replace it in the nozzle holder.

(7) Remove the fill cap and check that the tank is filled with free flowing, not caked, "purple K."

(8) Inspect the threads on the fill cap and fill opening for damage.

(9) Remove and examine the fill cap gaskets.

(10) Replace the fill cap tightly.

(11) Rotate each wheel to test the lubrication of the bearings. If wheels do not revolve smoothly, pressure-lubricate the bearing through the grease fitting on the hub.

b. Operation and maintenance of hand fire extinguisher.

(1) 30-lb extinguisher. To operate and refill the 30-lb fire extinguisher, take the following steps:

(a) Remove the safety pin from the plunger.

(b) Press down on the plunger handle; this ruptures the seal in the top of the nitrogen cylinder. The cylinder on the 30-lb extinguisher is located on the outside of the dry chemical tank.

(c) Press the nozzle handle and attack the fire.

(d) After the extinguisher is empty, remove the dry chemical cap and refill the tank with 30 pounds of dry chemical. Remove the nitrogen cylinder from the plunger cap and replace with a new cylinder.

(e) Replace the safety pin and seal with a safety wire.

(2) Operator's maintenance. Operator's maintenance for hand-operated fire extinguishers consists of inspecting, repairing, replacing, or reporting. This service should be done on a daily basis and all discrepancies corrected immediately to assure the readiness of the equipment. The following steps comprise this maintenance:

(a) Inspect the general appearance for missing components, damage, corrosion, and cleaniness.

(b) Inspect the condition of the hose. Check for hose and nozzle obstructions.

(c) Remove the fill cap and check that the tank is filled with free flowing, not caked "purple K."

(d) Inspect the threads on the fill cap and fill the opening for damage.

(e) Inspect the fill cap gasket and insure that the cap is screwed on tightly.

(f) To inspect the nitrogen cylinder, unscrew the pressure cartridge and inspect the cartridge seal to see that it has not been punctured.

(g) The safety pin should be installed correctly with a seal and a safety wire.

(3) 150-lb wheel-mounted (fig 4-6). The 150-lb wheel-mounted fire extinguisher has great firefighting capabilities; one should be located in each tank farm, booster station, and beach unloading station. This extinguisher has a 35-foot range and will operate continuously for about 55 seconds.

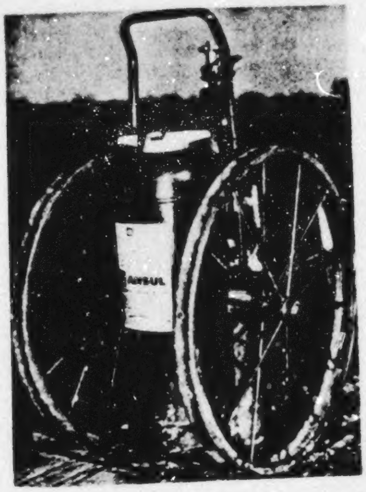


Fig 4-6. 150-lb wheel-mounted extinguisher.

(4) Operation and maintenance of the 150-pound wheel-mounted fire extinguisher.

(a) Operation

1. Before use. The following steps should be followed when inspecting the 150-pound wheel-mounted fire extinguisher:

Close the valve on the dry chemical tank.

Open the nitrogen cylinder valve. Check the high-pressure gage. The pressure gage should show a reading of 2,100 psi. If the reading is less than 1,500 psi, replace the cylinder with a new cylinder.

Shut off the nitrogen cylinder valve. Tip the fire extinguisher backwards to a horizontal position. In this position, the nitrogen cylinder will be on top of the dry chemical tank.

Remove the hose from the connection on the bottom of the dry chemical tank (1, fig 4-7).

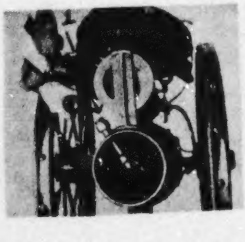


Fig 4-7. Disconnected hose.

Open the dry chemical tank valve. Gas pressure impounded in the high-pressure hose should force a small amount of dry chemical out of the hose connection located at the bottom of the dry chemical tank.

Recouple the hose to the connection at the bottom of the dry chemical tank.

Return the extinguisher to an upright position.

Remove the dry chemical tank fill cap. Inspect to see if the dry chemical tank is full (its capacity is 150 lbs).

Place a wire and lead seal on the nitrogen and dry chemical valve after each inspection.

2. During use. When the actual need to operate the 150-pound, wheel-mounted extinguisher occurs, proceed as follows:

Move the fire extinguisher as near to the fire as safety will permit.

Uncoil the hose from the hose rack to its full length.

Open the nitrogen cylinder valve.

Open the dry chemical tank valve.

Open the nozzle and attack the fire.

3. After use. After the extinguisher has been used it must be cleared and recharged; perform the following procedures:

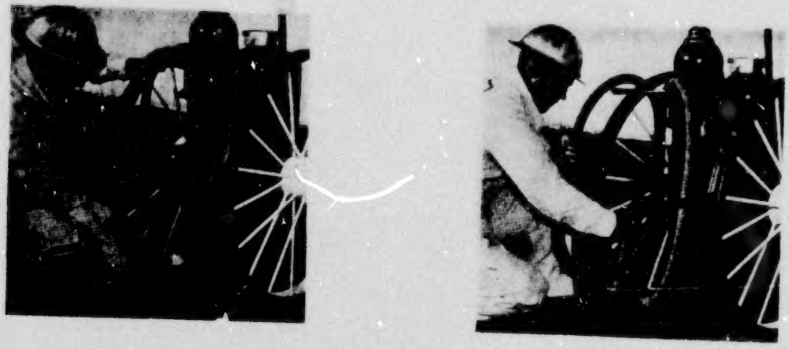
Close the nitrogen cylinder valve tightly.

To release pressure, tip the fire extinguisher backwards to a horizontal position and open the nozzle.

Return the extinguisher to an upright position after all the pressure is released.

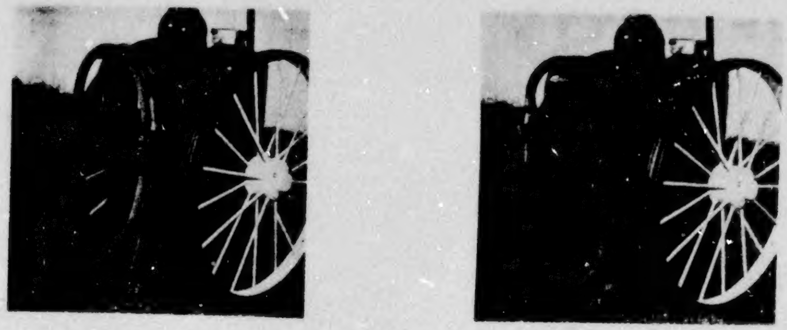
Check the pressure in the nitrogen cylinder; if the pressure reads less than 1,500 pounds, replace the cylinder with a new one.

Coil the hose over the hose hanger in the manner shown in figure 4-8.



1. First loop is started counter clockwise and completed by placing over rack. Coil should not touch ground.

2. A reverse loop follows the first. Notice that hose passes behind loop to make the reverse loop.



3. Alternate loops are reverse loops. Follow steps one and two until all hose is coiled in the cabinet.

4. Adjust coils so nozzle fits into the holder easily. Hose coiled in this manner will pull out free of twists.

Fig 4-8. Hose coiling method.

Close the nozzle and secure it in the nozzle holder.

Remove the fill cap from the extinguisher and refill with "purple K" to rated capacity.

Clean the seating surfaces and replace the fill cap tightly.

Seal the nitrogen cylinder valve in the closed position with a lead and wire seal.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The 30-lb. fire extinguisher has a range of 17 feet in a fan-shaped pattern with an __________ second operation.

2. The last step in operator's maintenance on the 30-lb. fire extinguisher is to

   a. inspect the general appearance for missing components.
   b. inspect the condition of the hose.
   c. inspect the nitrogen cylinder.
   d. install the safety pin correctly.

3. The 150-lb. wheel-mounted fire extinguisher has a 35-foot range for a period of about

   a. 35 seconds.
   b. 45 to 60 seconds.
   c. one minute.
   d. two minutes.

4. Hose should be coiled using an alternate reverse loop technique in order to

   a. present a neat appearance.
   b. prevent twisting.
   c. to clean powder out of the hose.
   d. prevent caking of the powder.

Work Unit 4-5. THE TWIN-AGENT UNIT FIRE EXTINGUISHER (TAU)

IDENTIFY FOUR OPERATING CAPABILITIES OF THE TAU.

The Twin-agent Unit (fig 4-9) is the best fire extinguisher the Marine Corps has in its inventory. You will find this extinguisher at both TAFDS and AAFS sites. One of these units can cover an entire six-tank farm with the use of the 150-foot remote hose reel. It may be used as a dry chemical as well as a foam fire extinguisher.

The chemical agents are expelled by pressurized nitrogen, stored on the unit, making the unit self-contained. The hoses are entwined by encasing them in a single cover for convenience in storage and use; the nozzles are close-coupled by a piston grip type bracket. The hose is stored on a twin hose reel at the front of the unit when not in use. Additional area coverage without moving the extinguisher is provided by a remote hose cart. This coverage is necessary to reach bulk fuel bladder tanks spaced sufficiently apart from each other to prevent secondary fires in adjacent tanks. Without the 150-foot remote hose cart, additional extinguishers would be required.

An extinguisher's firefighting capability is determined by the capability of its extinguishing agent, hose length, and the skill of the operator. The magnitude of the fuel tank fire is determined by the size and shape of the berm, wind velocity, and the type of fuel. If the bladder tanks are installed too close together within the tank farm, a second tank and probably all six, will become involved in the fire. Although the unit is capable of putting out a fire in a single berm, there is one drawback. You should have three Marines helping to extinguish the fire; one to operate the nozzle and two to maneuver the hose. These three Marines should be well trained in the operation of the unit in order to relieve each other. The hose, when used in operation, will weigh approximately 500 pounds. In addition to this limitation, these Marines must wear protective clothing for safety.

General Operation. Successful extinction of a fire requires a close-in position with the wind at the unit operator's back. Since wind direction is important, the unit should always be positioned in an upwind location. This causes the fire to be blown away from the unit, relieving excess heat from both equipment and the operator. The range of the unit is 40-50 feet; therefore, it would be harder to effectively operate if it was pointed into the wind.

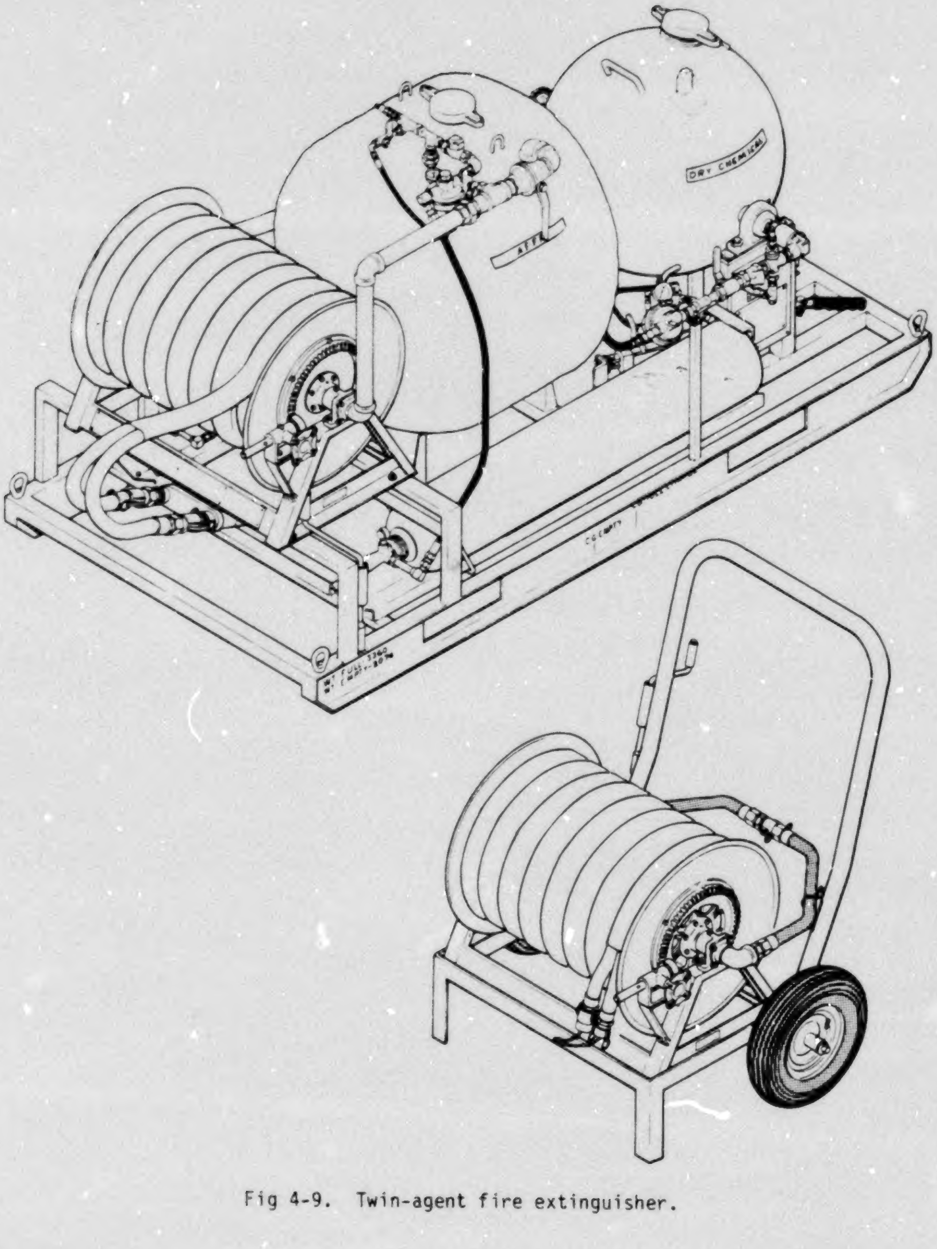

DRY CHEMICAL
CG EMPTY
WT FULL 3360

Fig 4-9. Twin-agent fire extinguisher.

a. Protective clothing. Because the fire must be contained quickly, the firefighter must work in close proximity to the fire. Due to the intense heat generated by the fire, the firefighter must wear protective clothing. Figures 4-11 through 4-14 illustrate the protective clothing that must be worn. With the exception of the boots, all of the protective clothing is aluminized. This means that it is designed to reflect radiant heat. In addition to the equipment shown, there are also aluminized gloves.

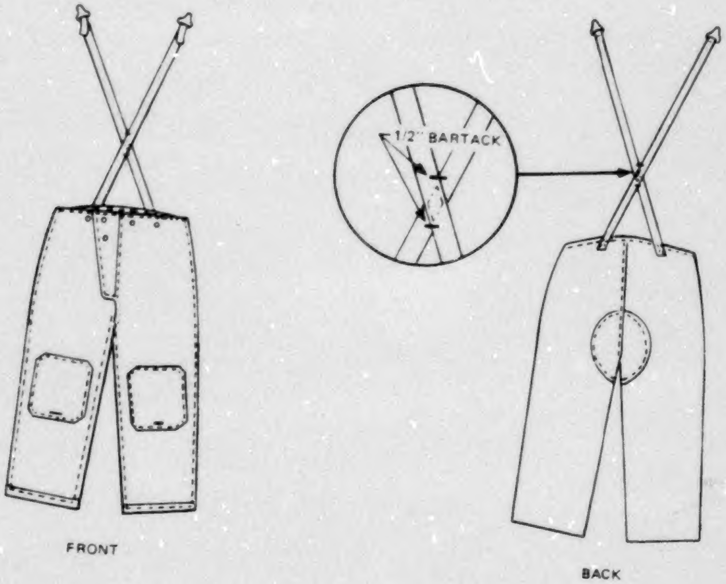


Fig 4-10. Fireman's aluminized proximity trousers.

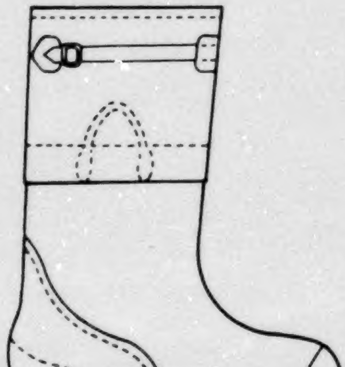


Fig 4-11. Fireman's cold weather boots.

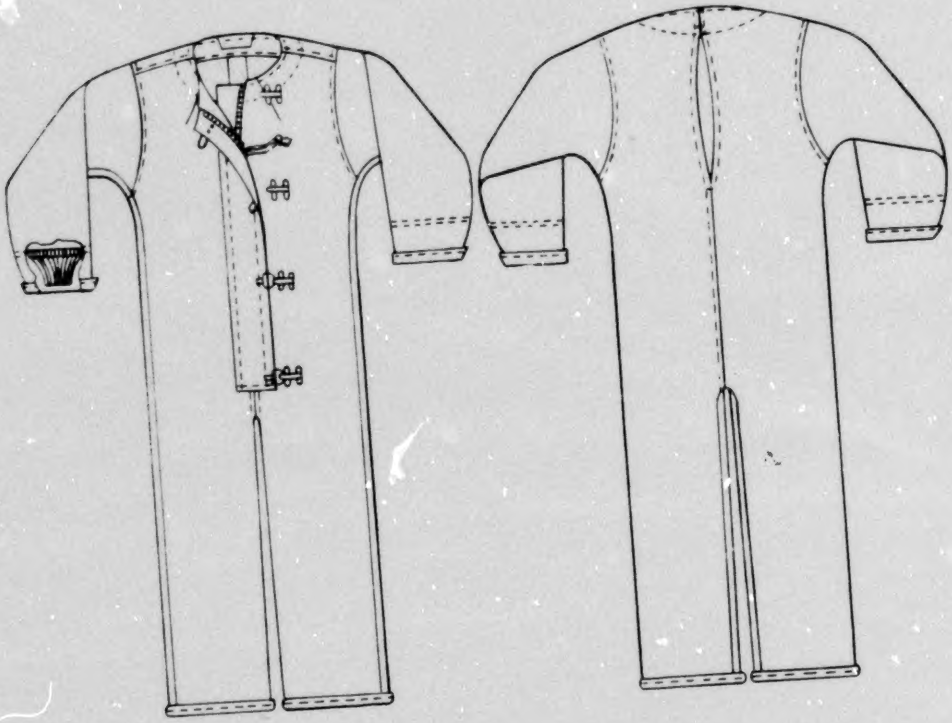


Fig 4-12. Fireman's aluminized proximity coveralls.

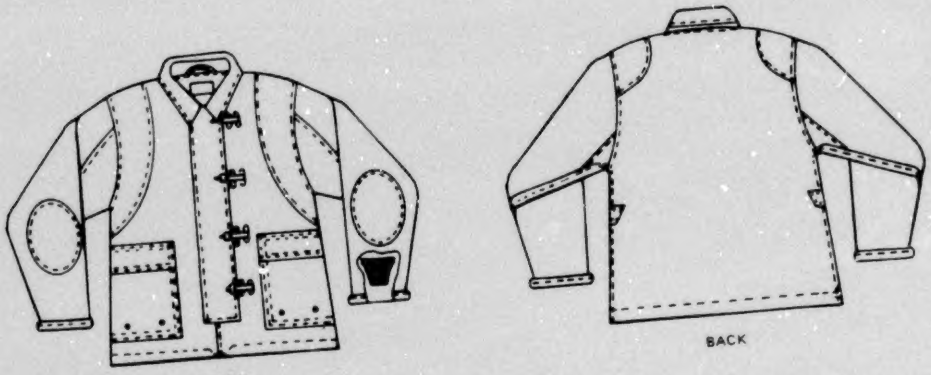
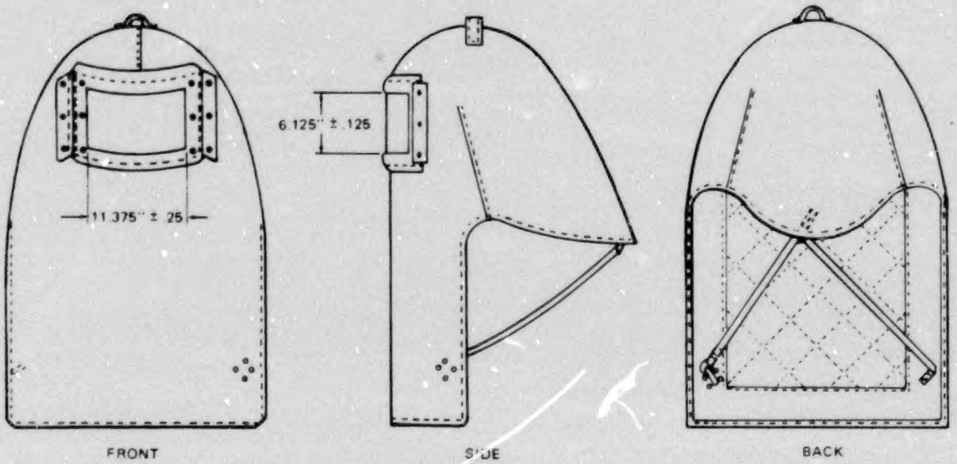
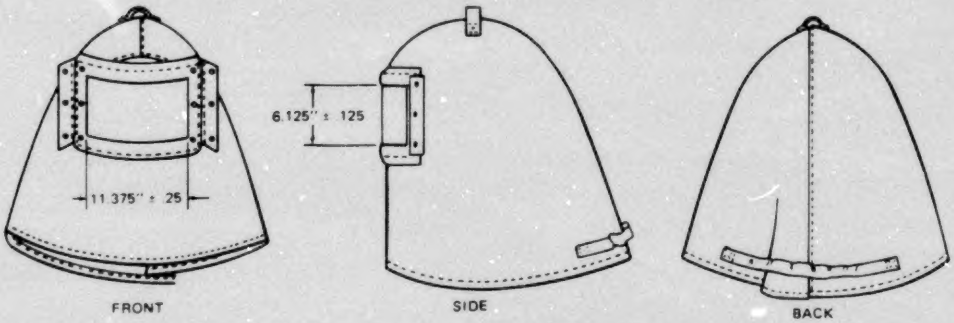


Fig 4-13. Fireman's aluminized proximity coat.



TYPE II - WITH FRONT APRON



TYPE I - SHOULDER LENGTH

Fig 4-14. Fireman's aluminized proximity hoods, types I and II.

Theory of Operation

AFFF SYSTEM. Nitrogen gas, N_2, is used to expel both chemical agents. In order to store the required quantities, the nitrogen is provided in steel cylinders at 2400 psi, which is excessive for use in the systems. When the valve on the AFFF system cylinder is opened, then, the nitrogen flows first to a pressure regulator, where it is reduced to 230-250 psi working pressure. The reduced pressure is indicated on a 0-400 psi gauge installed in the low pressure side of the regulator. From the regulator the nitrogen passes through a check valve, installed to prevent back flow of AFFF into the regulator when the nitrogen cylinder pressure dissipates, to a pipe cross. A pressure relief valve is installed in one of the cross outlets, and relieves pressure if the system inadvertantly reaches 275 psi. A bypass valve is installed in another of the cross outlets, and is closed during normal operation. From the remaining outlet of the cross the nitrogen flows to the AFFF tank, pressurizing the tank to 230-250 psi. When the AFFF nozzle is opened, the AFFF solution will be forced out the pickup tubes in the bottom of the tank, through the normally open discharge valve to the hose reel, hoses and discharge nozzle.

DRY CHEMICAL SYSTEM. When the dry chemical system nitrogen cylinder valve is opened the nitrogen flows to a pressure regulator, is reduced to 230-250 psi working pressure just as it did in the AFFF system. From there, however, the dry chemical system functions somewhat differently. From the regulator the nitrogen takes two paths. One line leads through the normally open test valve and check valve, through a cross which houses a pressure relief valve and normally closed bleed valve, and on to pressurize the dry chemical sphere. With the sphere in its upright position, however, very little (if any) dry chemical will be discharged, even with the discharge nozzle open. The pickup tube openings inside the sphere are at the top of the sphere, above the dry chemical. This arrangement serves two important purposes; first, the dry chemical powder cannot become packed in the pickup tube opening; secondly, the sphere can be pressurized in the upright position without discharging dry chemical power. To pressurize the sphere without discharging powder requires that the sphere be firmly latched in the upright position during pressurization. The second path the nitrogen takes from the regulator leads through another cross, housing two normally closed bleed valves, to the dry chemical sphere latch cylinder. The nitrogen pressure working on the piston in the latch cylinder forces the sphere up-latch open, allowing the sphere to freefall to the inverted position. This action not only places the dry chemical pickup tube below the dry chemical powder; it loosens the powder, helping the nitrogen pressure aerate the chemical. When the dry chemical discharge valve is opened the nitrogen leaves the sphere with the dry chemical suspended in it and is carried along by the velocity of the moving gas. The mixture of dry chemical and nitrogen passes through the hose reel and hose and is discharged through the dry chemical nozzle.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The Twin-Agent Unit can provide firefighting capabilities to a six-tank farm with the use of the 150-foot

a. hose.	c. extension.
b. remote hose reel.	d. discharge lines.

2. The Twin-Agent Unit has a range of ________ feet.

a. 40-50	c. 35
b. 17	d. 30-40

3. The extinguisher consists of two completely independent systems: the AFFF and

a. carbon dioxide.	c. dry chemical.
b. nitrogen.	d. aqueous foam.

Work Unit 4-6. FIREFIGHTING METHODS

GIVEN THREE TYPES OF FIRES AND THEIR CHARACTERISTICS, MATCH EACH TYPE OF FIRE WITH ITS CHARACTERSTIC.

General. Due to the nature of the equipment employed in the bulk fuel system, fires of differing degrees of severity can be expected in various components of the system. Hoses, valves, manifolds, or any place there is a connecting point in the system represents a potential leakage problem. Loose or missing gaskets or loose connections are sources for this type of hazard. Constant inspection of the system should prevent the danger. If a fire should erupt in one of these areas, a hand portable fire extinguisher should be within reach to combat it. In portable systems of this type, frequent moving or changing represents a fire hazard from fuel-contaminated equipment. For example, a hose is moved and the fuel in it is spilled on the ground or a hose to a pump manifold is disconnected and fuel is spilled; in handling equipment of this type, this situation is impossible to avoid. Again, reasonable care should keep the extent of fires of this nature within the reach of hand portable fire extinguishers. The danger of a large pressure fire is always present, but since this type of fire will normally occur in the hose system, it can be handled by shutting off the fuel pressure to the ruptured component, either by shutting down a pump, closing a valve, or using a hose clamp. If none of these alternatives are possible, the resulting fire will be beyond the range of hand portable units and larger extinguishing equipment will have to be used. Finally, the most severe hazard in a bulk fuel system is in the tanks themselves. In this case, prevention is obtained by detailed attention to the elimination of leaks and spills and absolute prevention of all sparks and ignition sources.

Types of fires

a. Two-dimensional fire. A 2-dimensional fire, such as a pan or pit fire, is of a flat surface type which usually requires only one firefighter.

b. Three-dimensional fire. This type of fire is one with obstacles, which could be either a spill or pressure fire. Obstacles to consider are manifolds, tanks, or any item of equipment preventing one operator from reaching both sides of the fire. A second firefighter is required and, working as a team, from angles differing in approach, two men can be very effective. If this is a pressure fire, the pressure should be shut off before the fire is attacked, if possible. If the pressure cannot be shut off, the flow of the chemical should be directed at the break. After the chemical has extinguished the flame at the break, follow out from that point and extinguish the remaining spill fire. In a case where the break is gravity-fed rather than pressure-fed, you would reverse this action and attack the spill fire first, then direct the stream of chemical to the break.

c. Full-scale fire. This type of fire requires the maximum combined effort of all available firefighters and equipment. Not only is fast coordinated action needed to extinguish it but also protection to surrounding equipment must be provided. During a full-scale fire, one man should direct and control the firefighters and equipment. When fighting any fuel fire you must keep calm and follow the basic methods of controlling and extinguishing. Always approach the fire with the wind at your back. Attack the edge of the fire first, always keeping the fire ahead of the dry chemical. When progressing satisfactorily, be on the alert for "flashback," or re-ignition from the radiant heat. "Never turn your back on a fire," but always back away watching other firefighters that might be working with you. You should work as a team, never leaving your buddy in the fire. Both must leave when the first extinguisher runs out. Dry chemical should be applied directly in front and at the bottom of the flames to create a rolling effect of the dry chemical into the fire. Using the full reach of the spray keeps you back from the heat and allows the flow of chemical to spread before hitting the surface. The dry chemical must be applied in a fast sweeping motion, sweeping from side to side, extending slightly outside the limits of the fire. To prevent flashback, do not pick out points in the fire to extinguish; continue a constant sweep until the fire is extinguished. Cooling down the berms is a final step in securing fires.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

Matching: Column 1 (items 1 through 3) lists the three types of fires. Column 2 (a through c) lists descriptions for each of the three types of fires. Match the type of fire in column 1 with its particular characteristic(s) in column 2. Place your answers in the spaces provided.

	Column 1 Type of fires	Column 2 Characteristics
____	1. Two-dimensional fire	a. Fire with obstacles
____	2. Three-dimensional fire	b. Requires maximum effort
____	3. Full scale fire	c. Pan or pit fire

SUMMARY REVIEW

Now that you have completed the last study unit of this course, you have learned the safety and firefighting guidelines necessary for you to follow as a bulk fuel man. You learned to identify the various items of firefighting equipment and the preventive maintenance and trouble-shooting procedures required to maintain and service the various items of this equipment. Lastly, you learned the capabilities and limitations of the Marine Corps firefighting equipment.

Answers to Study Unit #4 Exercises

Work Unit 4-1.

1. b.
2. a.
3. b.
4. d.
5. c.
6. a.

Work Unit 4-2.

1. b.
2. d.
3. c.
4. d.
5. b.
6. a.

Work Unit 4-3.

1. c.
2. a.
3. b.
4. Purple "K," a dry, potassium chemical

Work Unit 4-4.

1. 8-12 second.
2. d.
3. b.
4. b.

Work Unit 4-5.

1. b.
2. a.
3. c.

Work Unit 4-6.

1. c.
2. a.
3. b.

APPENDIX A

EQUIPMENT DEVELOPMENT

The how and why of Bulk Fuel Equipment starts with the Bulk Fuel Man at the unit level. When you have an idea of how things can be improved, you should pass on your ideas. The why of it is that if your ideas are not passed on, then your ideas are not going to do any one any good.

Equipment that the Marine Corps receives is based on ideas that have been brought to the attention of Headquarters, Marine Corps. An idea undergoes an immense amount of investigation and study before it is adopted. When an idea looks promising it is then tested.

The Marine Corps Research and Development Center at Quantico tests these ideas that involve new equipment and procedures. The center tests equipment in freezing climates as well as in the hot desert areas. The equipment that it tests is obtained or procured by Headquarters, Marine Corps. Following the testing, a recommendation will be made as to whether the Marine Corps should buy the item of equipment.

In the event that the equipment is purchased, military specifications have already been written, and it is in accordance with these specifications that the equipment is purchased. The manufacturer of the item then will provide the item to the Marine Corps in the amount that is requested.

All equipment is procured in accordance with military specifications. If another manufacturer contracts for the same item and can meet the specifications, then the Marine Corps may buy it also. In Bulk Fuel, this is a problem: For example, nozzles may have the same military specifications yet they are obviously different in appearance. This is due to the different manufacturers that have contracted with the Marine Corps. This is also evident in the 350-GPM filter separators, when you may have a Keene or General Steel Tank Company or some other manufacturer model.

If equipment has been procured, then it has met the rigid requirements and will still function in the same manner for which it was intended. You must remain flexible in your training in Bulk Fuel in order to incorporate any changes or additions in the nomenclatures of the equipment.

GLOSSARY

BULK FUEL TERMS AND DEFINITIONS

American Chemical Society (ACS)	A professional society of chemists which formulates specifications and establishes standards for analytical reagents used in the laboratory. A product designated as "ACS," a purity designation, meets all requirements of the society.
American Petroleum Institute (API)	The institute represents and is supported by the petroleum industry. It standardizes the tools and equipment used by the industry and promotes the advancement of research in the petroleum field.
American Society for Testing and Materials (ASTM)	A national scientific and technical organization formed for the development of standards or characteristics and performance of materials, products, systems, and services and the promotion of related knowledge.
API Gravity. (Also see Specific Gravity)	An arbitrary scale expressing the gravity or density of liquid petroleum products. The measuring scale is calibrated in terms of degrees API. The gravity of any petroleum product is corrected to 60° F. It may be calculated in terms of the following formula: $\text{Degrees API gravity at } 60^\circ \text{F} \quad \frac{141.5}{\text{sp. gr.}} - 131.5$
Appearance	Refers to the visual examination of fuels. Terms used to describe appearance are clear and bright, hazy, and cloudy.
Automotive Gasoline (MOGAS)	A hydrocarbon fuel in the approximate composition range $C_5 H_{12}$ to $C_9 H_{20}$ for use in internal combustion engines and procured by the military under three specifications. Federal specification VV-G-76 provides for two grades (regular and premium) and for three classes (A, B, and C). Another specification for leaded and unleaded gasoline is VV-G-001690. Specification MIL-G-3056 specifies combat grade types I and II.
Aviation Fuels (AVFUELS)	Those refined petroleum products specifically formulated and blended for use in aircraft engines, both jet (reaction) engines and piston (reciprocating) engines. AVGAS (below) is an aviation fuel.
Aviation Gasoline (AVGAS).	A hydrocarbon fuel for use in reciprocating piston-type aircraft engines. AVGAS is characterized by low vapor pressure and distillation range and higher tetraethyllead content. It is procured by the military under Specification MIL-G-5572. Aviation gasoline 115/145 was replaced by 100/130 effective 1 June 1976.
Bonding	Electrically connecting units or containers before operations begin in order to equalize any static potential that might exist and to provide a continuous path for any state potential that might be generated after operations begin.
British Thermal Unit (B.t.u.)	The quantity of heat required to raise by 1° F the temperature of 1 pound of water at its maximum density (39.2° F).
Centrifugal Pump	An apparatus that builds up pressure head using centrifugal force as the principal means and angular velocity as the secondary means. (See Pump, Centrifugal (Volute Type).)
Change of Product	Change of service; refers generally to transporting or storing a product in a vessel, tank car or vehicle, storage tank, or other container, after having transported or stored a different product previously. The difference between the two products governs the nature and extent of preparations (draining, flushing, cleaning) needed before the change can be made.
Check Valve	A one-way nonreturn valve that permits fluids to pass in one direction only. The valve closes when the pressure causing flow stops.

Class III. POL:	Petroleum fuels: lubricants, hydraulic and insulating oils, preservatives, liquid and compressed gases, chemical products, coolants, deicing and antifreeze compounds, together with components and additives of such products and coal.
Class III A (Air)	Petroleum and chemical products used in support of aircraft.
Class of Fires	Class A, fires of ordinary combustibles, such as paper, wood, textiles, or rubbish, and extinguished by water. 2. Class B, fires of flammable liquids like gasoline, oil, grease, and extinguished by smothering. 3. Class C, fires involving electrical equipment, and extinguished by nonconducting agents. 4. Class D, fires involving burning metal.
Clean and Bright	Clean is the absence of visible solids, a cloud, a haze, an emulsion, or free water in the product. Bright is the sparkle of clean, dry product in transmitted light.
Coalescing	1. Drawing together, combining, or uniting to form one body. 2. A method of separating finely divided or suspended water from a petroleum product by passing the product through filter media of a filter/separator.
Contaminant	A foreign substance in a product.
Contaminated Product	A product in which one or more grades or types of products have been inadvertently mixed; or a product containing foreign matter such as dust, dirt, rust, water, or emulsions.
Contamination	The addition to a petroleum product or some material not normally present. Common contaminants are water, dirt, sand, rust, mil scale, and other petroleum products.
Coordinating Fuel and Equipment Research Committee (CFR)	This committee is composed of engine-manufacturing, petroleum-refining, petroleum-marketing, university, Government, and other technical representatives who supervise cooperative testing and study of engine fuels for the Coordinating Research Council, Inc.
Copper Strip Corrosion	A qualitative method of determining the corrosivity of a product by its effects on a small strip of polished copper suspended or placed in the product.
Corrosion	Rusting; a gradual eating away or oxidation such as the action of moist air on steel, and the more rapid chemical action of acid on metal or steel.
Corrosion Fatigue	Metal fatigue accompanied and aggravated by corrosion.
Density	Specific weight or mass of a substance per unit volume (pounds per cubic foot or gallon or grams per cubic centimeter). Specific gravity is the ratio of the mass of any volume of a substance to the mass of an equal volume of some standard substance (water in the case of liquids and hydrogen or air in the case of gases) at 40° C.
Deterioration	Any undesirable chemical or physical change that takes place in a product during storage or use. Some of the more common forms of deterioration are weathering, gum formation, weakening of additives, and change in color.
Diesel Engine	An internal-combustion engine in which air, drawn in by the action stroke, is so highly compressed that the heat generated ignites the fuel, which is automatically sprayed into the cylinder under high pressure.
Diesel Fuel	A hydrocarbon fuel used in diesel engines. Diesel fuels used by the Armed Forces are manufactured under two specifications: VV-F-800, which provides for three grades (DF-1 -2, and -A); and MIL-F-16884, which provides one grade (Marine).

Differential Pressure	The difference between suction pressure and discharge pressure of a pump; increment of pressure added by each pump operating in series in a pump station; pressure drop or loss between the inlet and outlet of a filter, meter, or other necessary offering resistance to flow.
Distillation	Vaporization of a liquid and its subsequent condensation in a different chamber. In refining, it refers to the separation of one group of petroleum constituents from another by means of volitization in some form of closed apparatus, such as a still by the aid of heat. Any distillation made in accordance with an ASTM distillation procedure; especially, a distillation test made on such products as gasolines, jet or turbine fuels, and kerosene to determine the initial and final boiling points and the boiling range.
Drum, Collapsible	A 500-gallon collapsible fabric drum. (All other sizes of liquid fuel collapsible containers are considered tanks, not drums.)
Dynamic Head	A measure of pressure in liquids in motion; a measure of potential energy or energy of position; the static head required to accelerate the stream to its flowing velocity; the elevation to which a pump can push a column of liquid.
Emulsion	A suspension or dispersion of fine droplets of one liquid in another. An oil emulsion, a common form of emulsion, is oil suspended in water. A water emulsion is water suspended in oil. The lighter the product, the more rapidly emulsions break down; the heavier the product, the more persistent emulsions become. An emulsifier or emulsifying agent is a substance used to promote formation of stable emulsions. Emulsifying or emulsification is formation of emulsions; demulsifying or demulsification is breaking down emulsions.
Filter (noun)	A porous material on which solid particles are caught and retained when a mixture of liquids and solids is passed through it.
Filter (verb)	To remove mechanically the solids or free water from a petroleum product.
Filter/Separator	A device used to separate both solid contaminants and water from a petroleum fuel.
Flammable	A term describing any combustible material which can be ignited easily and which will burn rapidly. Petroleum products which have flashpoints of 80° F. or lower are classed as flammable.
Flashpoint	The lowest temperature at which vapors arising from a petroleum product will ignite momentarily (i.e., flash) on application of a flame under specified conditions.
Floating-Roof Tank	A tank with a roof that floats on the surface of the liquid contents. The roof, which has a tight seal of synthetic rubber around its perimeter, rises and falls with the changes in product level. When the roof falls to a certain distance from the bottom, it comes to rest on supports. Because there is no vapor space between the surface of the product and the roof, breathing and filing losses are practically eliminated.
Gage (noun)	An object used as a standard of measurement or composition, i.e., an instrument for measuring, indicating, or regulating the capacity, quantity, amount, or other properties of anything.
Gage (verb)	To measure the contents or capacity, as of a tank.
Gallon (gal.)	A unit of measure of volume. A U.S. gallon contains 231 cubic inches or 3,785 liters; it is 0.83268 times the imperial gallon. One U.S. gallon of water weighs 8.3374 pounds at 60° F.
Gas	A form of matter. A fixed gas is a substance, natural or manufactured, which exists as a gas under ordinary conditions. The term is often used loosely to refer to a fume or vapor.

Gas Detector	An instrument for determining the explosibility of a gas-air mixture; explosimeter.
Grounding	Electrically connecting single or bonded units to a ground rod so that any static potential that might exist or that might be generated will be discharged into the earth. If two or more units are bonded and one is grounded, the whole system is effectively grounded. (See Bonding.)
Ground Products	These refined petroleum products normally intended for use in administrative, combat, and tactical vehicles, materials-handling equipment, special-purpose vehicles, and stationary power and heating equipment.
Gum	Varnish-like, tacky, noncombustible insoluble deposits formed during the deterioration of petroleum and its products, particularly gasoline. The amount of gummy material in gasoline is known as its gum content.
Gum Test	An analytical method for determining the amount of existing gum in gasoline by evaporating a sample from a glass dish on an elevated-temperature bath with the aid of circulating air.
Impeller	A device which impels or pushes forward, such as the rotor of a centrifugal pump or air compressor.
Incremental Pressure	The difference between the suction and discharge pressure of a pump or of a multipump pump station.
Internal-Combustion Engine	An engine which operates by means of combustion of a fuel within its cylinders.
Jet Engine	An engine which converts air and fuel into a fast-moving stream of hot gases which effect propulsion of the device of which the engine is a part.
Jet Fuel	Fuel meeting the required properties for use in jet engines and aircraft turbine engines. Jet fuels are procured for the Armed Forces in several grades. The most important grades are JP-4 (low vapor pressure) and JP-5 (high flashpoint), both produced under Specification MIL-T-5624 and designed for use in aircraft turbine engines. JP-6, produced under Specification MIL-J-25656, is designed for use in aircraft turbine and jet engines of land-based supersonic aircraft. RJ-1, produced under Specification MIL-F-25558, is designed for use in ramjet aircraft engines. Jet fuel is usually called JP (jet propulsion) fuel.
Joint Petroleum Office (JPO)	An office established by the Joint Chiefs of Staff to discharge staff petroleum logistics responsibilities in a Unified Command overseas.
Kerosene	A refined petroleum distillate used in space heating units, in wick-fed lamps, in bomb-type flares, for cleaning certain machinery and tools, and as a vehicle for liquid insecticide sprays. A single multiple-use type is procured under Federal Specification VV-K-211. A deodorized type, which is used as a vehicle for insecticide sprays, is procured under Specification VV-K-220.
Lubricant	A substance, especially oil, grease, and graphite, which may be interposed between moving surfaces to reduce friction and wear.
Manifold	A piping arrangement which permits a stream of liquid or gas to be divided into two or more streams, or which permits several streams to be collected into one.
Mass	Quantity of matter. Mass remains constant, but the weight of a mass varies with the pull of gravity. Specific gravity is the ratio between the weight of a quantity or mass of a substance and the weight of an equal quantity of water. Weight equals mass times the pull of gravity.

Multipurpose Grease	A lubricating grease suitable for use as a chassis lubricant, a bearing lubricant, a joint lubricant, a water pump lubricant, and as a cup grease, such as grease, automotive, and artillery (Specification MIL-G-10924).
Napalm	A thickened gasoline used as an incendiary medium. It tends to adhere to the surface it strikes.
Oxidation	1. The process of combining with oxygen, which all hydrocarbons are capable of doing. 2. Oxidation characteristics of crankcase lubricating oils include their resistance to oxidation, their bearing corrosion characteristics, and the deposit of contaminants that result from oxidation. Oxidation stability of aviation fuels refers to the amount of gum and lead precipitate formed as a result of accelerated oxidation (potential gum). Oxidation stability of lubricating greases refers to resistance of greases to change under static conditions for long periods; for example, when applied to antifriction bearings or motor part.
Pascal's Law	A theorem that pressure applied to the surface of a confined liquid is transmitted equally and undiminished in all directions and acts at right angles to the confining surfaces.
Penetrating Oil	A thin, nonviscous oil used to loosen rusted or frozen metal parts such as nuts, screws, bolts, or pins. Penetrating oil is not intended for use as a lubricant. It is produced to Specification VV-P-216.
Performance Number (PN)	An indication of relative engine performance, the relative knock-free power or output a supercharged aircraft engine can develop. Avgrade 115/145, for example, indicates a rating of 115 at lean mixture and a rating of 145 at rich mixture. The rating 145 indicates that the engine can develop 145 percent as much knock-free power with the fuel at rich mixture as it could under the same conditions with a fuel having a performance number of 100.
Petrochemical	A contraction of the words "petroleum" and "chemical," originally coined to designate chemicals of petroleum origin. At present, petrochemical is so loosely used and covers such a wide variety of products that it cannot be defined specifically.
Petrol	A British term for petroleum; gasoline.
Petrolatum	A purified mixture of liquid or semisolid hydrocarbons. Jelly-like petrolatum is used as a basis for ointments and as a lubricant of limited application.
Petroleum	Crude oil. Petroleum is a mixture of gaseous, liquid, and semisolid hydrocarbons varying widely in gravity and complexity. Petroleum is capable of being removed as a liquid from underground reservoirs of accumulation, and it is capable of being separated into various fractions by distillation and recovery. Petroleum burner fuels include those fuels burned under boilers or in furnaces for power or heat.
Pressure	A force or impulse. Pressure differential is incremental pressure, or the difference between suction and discharge pressure of a pump. Pressure gage is an instrument used to measure and indicate pressure in a fluid. Pressure head is the pressure produced by a pump or by the weight of a column of liquid. Pressure lock is a device for gaging a pressure vessel. It consists of a gaging tape and bob housed in a vaportight assembly with a shutoff valve and mounted on top of the tank. Pressure reducing valve is a diaphragm-operated, spring-loaded pressure regulator used on long downgrade slopes to prevent the buildup of excessive hydrostatic pressures when the line is shut down. Pressure vessel is an enclosed tank or other container in which a pressure greater than atmospheric is maintained.

Priming	Displacement of air on the suction side of a centrifugal pump between the source of supply and the point of intake in the pump. Priming can be done by filling the pump casing with product to be pumped or by removing the air with a vacuum pump. A foot valve or check valve can be installed on the suction line to hold product when pumping stops.
Pump	An apparatus for lifting or transferring fluids. The following are principal types of pumps.
Pump, Centrifugal (Volute Type)	Consists or one or more impellers mounted on a rapidly rotating shaft. The liquid enters the impeller at the center, or "eye," and is impelled outward from the center by centrifugal force at high velocity into the volute of the pump casing. The function of the volute is to catch the impeller discharge and convert peripheral (tangential) velocity head into pressure head while conducting the liquid at a reducing rate of flow to the discharge nozzle of the pump casing.
Pump, Duplex	A reciprocating pump which has two liquid cylinders. Duplex pumps have a more steady discharge flow and pressure than do simplex pumps.
Pump, Gear	A positive-displacement pump of the rotary type that moves liquid by means of meshing gears rotating in opposite directions. Liquid enters on the suction side under atmospheric pressure and is carried to the discharge side in the spaces between the gear teeth and the wall of the pump chamber.
Pump, Multistage	A centrifugal pump which has two or more impellers mounted on the same shaft. The discharge from one impeller is conducted to the suction eye of the next impeller, etc. Petroleum products pumps with up to 14 stages and developing over 3,000 p.s.i. discharge pressure are in use.
Pump, Power	A reciprocating pump in which the liquid pistons are driven by other means than rods connected to direct acting steams pistons, usually by a crankshaft driven through gears or speed reducer by an automotive engine or electric motor.
Pump, Reciprocating	Consists of one or more cylinders into which liquid is sucked on the intake stroke of a piston and discharged on the discharged stroke. It is usually driven by a direct-connected steam piston, although installations employing belt, gear, or chain drive by steam turbine, diesel engine, or electric motor may be used. It may commonly be of simplex, duplex, or triplex (one-, two-, or three-pump cylinders) and be single acting (one working stroke per revolution using one side of piston) or double-acting (two working strokes per revolution using both sides of piston). This pump is essentially a low-speed, low-capacity pump, and is best suited to the handling of small quantities of viscuous liquids at high heads and variable discharge pressures.
Pump, Rotary	A positive-displacement pump used mainly to pump liquids that are either too viscous or too volatile to readily pick up from a lower lever with a centrifugal pump. There are many types of rotary pump designs. The most common types are the gear-type and lob-type, in which two gears or lobes mesh and, therefore, rotate in opposite directions, with very close clearances between the rubbing surfaces and the closely fitting casing. The liquid is trapped between the gear teeth or lobes and the casing and is carried around to the discharge side of the pump. The close meshing and minimum clearances prevent the liquid from bypassing to the suction side.
Pump, Simplex	A reciprocating pump that has one liquid cylinder on a direct rod drive, or is driven by a single crank or rocker arm.
Pump, Single Acting	A reciprocating pump that discharges when the piston is moving in one direction only; contrasted with a double acting pump in which liquid continuously enters and leaves the cylinder from one end or the other.
Pump Booster	When the pressure fluid flowing in a pipe is nearly expended and approaches zero, a booster pump is used to impart additional energy to the fluid. The energy thus imparted can be used to increase flow rate.

Quality Control	The aggregate of measures taken to insure that petroleum products accepted by the Government are of the required quality when delivered to the user. Quality control includes watching over and caring for products during all storage and handling operations, adherence to handling methods and procedures designed to protect quality, and examination and testing of products in storage and on change of custody.
Reciprocating	Moving alternately back and forth. A reciprocating engine or group (positive displacement) is one in which pistons move back and forth in cylinders; reciprocation is converted to rotary motion, or vice versa, by connecting pistons to cranks.
Reciprocating Pump	See Pump, Reciprocating.
Reclamation	Restoring or changing a contaminated or off-specification petroleum product so that it will either meet specifications completely or will be within usable limits. (See Blending.)
Rising Stem	Refers to one type of gate valve in which only the valve stem and disk rise together when the valve is opened. This contrasts with the nonrising stem valve on which the handwheel, valve stem, and disk rise together when the valve is opened.
SAE Numbers of Lubricants	A classification of lubricating oils for crankcases and transmissions in terms of viscosity only, standardized by the Society of Automotive Engineers (SAE).
Sample	A quantity of product taken for examination and testing.
Sampler	A device used to obtain samples of various petroleum products. Other terms for sampler are thief or cheater.
Scale	1. A tool or instrument with a series of marks along a line at regulated or graduated distances, used for measuring or computing. 2. A formation of oxide in a flaky film or in thin layers.
Sediment	Foreign matter other than water that settles to the bottom of a container.
Segregator	Filter/separator or water separator. A device for removing water from a stream of product.
Sludge	A heavy sedimentation or deposit on the bottom of storage tanks consisting of water, dirt, and other settlings; gunk. Crude oils and residuals form the heaviest sludges, and light products form lesser sludges. Engine sludge is a particular kind of sludge containing products of combustion deposited in internal combustion engines.
Specific Gravity (Sp. Gr.)	The ratio of the weight of any quantity of matter, a petroleum product for example, to the weight of an equal quantity of water; usually determined by use of a hydrometer. (See API Gravity.) The formula for converting specific gravity to degrees API gravity is as follows: $\text{Specific gravity} = \frac{141.5}{\text{API} + 131.5}$
Static Electricity	Stationary, electric potential generated by friction between unlike substances in the atmosphere; contrasted with voltaic or current electricity.
Static Pressure	Hydrostatic pressure produced with a column of liquid because of weight alone; measured by feet of head.
Strainer	A screen, sieve, or filter.

Suction	An effect of atmospheric pressure. Pumps cannot exert a negative force on liquids in the intake line. They can only exhaust or pump out the air from the line, and atmospheric pressure, acting on the source of supply, pushes or lifts liquid up to the pump. The limit of such a lift is the height to which a force of 14.7 pounds per square inch can raise the product. Reciprocating pumps can pump air better than centrifugal pumps, and it is for this reason that centrifugal pumps usually have to be primed or filled with the product to displace the air. Suction pressure should be understood to mean pressure on the suction side of the pump.
Surge Pressure	A rapid increase in pressure in a flowing stream caused by the too rapid closing of a valve. A surge tank or chamber is a receiver intended to absorb or to compensate for sudden fluctuations in pressure.
Suspension	Dispersion in a liquid or in a gas of small particles of a solid substance or of small droplets of a liquid. Smoke is a suspension of particles of carbon in gases of combustion; fumes are a suspension of solid particles in air. Fog is a dense suspension of water droplets in air. Mist is a less dense suspension of water droplets in air. An emulsion is a suspension of oil droplets in water or water droplets in oil.
Tank	A storage container for liquid products. Tankage refers to tanks collectively. Tank car is cylindrical metal tank mounted on a frame and on railway freight car trucks. Tank bottoms are the contents below the suction or drawoff line. Tank or tank car heater is a stream coil on the tank bottom used to reduce viscosity for easy handling of product. Tank farm is a group of storage tanks connected by pipe and manifold. Tank gaging is measurement of innage of outage and observation of temperature and specific gravity to determine volume of contents 60° F. Tank truck (or semitrailer) is a tank shell mounted on a chassis for highway travel. Tank and pump unit is an assemblage of small-sized tanks and dispenser assembly suitable for mounting in a cargo truck.
Tanker	A seagoing vessel for transportation of liquids. Coastal tanks have less draft (depth of a ship below the water line) than ocean-going tankers.
Tolerance	An allowable variation from a specified limit. A blending tolerance, for example, is the greatest percentage of a substance that can be added to a product without putting the product too far off specification.
Upgrade	1. A grade that slopes upward in the direction of pipeline flow. 2. To change service from a dark or heavy product to a light or volatile product, refers to the nature of a product stored in a tank or transported in a tanker, tank car, or tank truck. 3. To blend a higher grade gasoline interface into tankage containing a lower grade gasoline.
Upstream	Opposite to the direction of pipeline flow; contrasted with downstream or the direction of pipeline flow.
Vacuum	A space entirely devoid of matter (called specifically "absolute vacuum"); a space, as the interior of a closed vessel, exhausted to some degree by an air pump or other artificial means. (Any vacuum less than absolute is a partial vacuum.) When a pump removes a part of the air from its suction line (creates a partial vacuum), atmospheric pressure lifts fluid up to the intake. The theoretical limit of this lift (in the case of a perfect vacuum), is the height to which the fluid can be lifted by a pressure of 14.7 pounds per square inch (atmospheric pressure at sea level).
Valve	A device used to control flow of fluids.

Vapor	The gas-like form of a substance that is normally a solid or a liquid; any gaseous substance that can be condensed by cooling or compression. Vapor density is the relative weight of a gas or vapor compared with the weight of an equal volume of a standard substance like air or hydrogen. Vapor lock is a condition in a fuel system, or in a pumping system, in which vaporized fuel, or product, is blocking or retarding flow of fuel to the carburetor; or flow of product through the pump. Vapor pressure is the pressure in a closed vessel exerted by the vapors released from any volatile product at a given temperature. Vapor space is the free area in a container above the level of the product. Vapor testing is a means of detecting the presence of flammable gas or vapor and measuring its concentration by means of a gas detector. Vaporization is the conversion of a liquid to its vapor, or evaporation.
Velocity of Flow	Rate of flow measured usually in feet per seconds equal to volume of flow in cubic feet per second divided by the cross sectional area of the pipe in square feet. Velocity head is the head in feet equivalent to the velocity in feet per second; equal to the square of the velocity divided by twice the acceleration of gravity in feet per second (64.3).
Vent	An opening in a tank or other container that permits inflow of air during periods of falling temperature or when pumping or pouring from the container or when filling the container the air and vapor exist during periods of rising temperature. Some vents have controls that are set to prevent intake of air or release of vapors the vacuum or pressure reaches a critical point.
Viscosity	Internal resistance to flow; usually measured as time in seconds for a given quantity of sample to flow through a standard capillary tube. Viscosity index is a means of rating resistance to change in viscosity with change in temperature. Oils of high viscosity index are more resistant to change; oils of low viscosity index thicken quickly when chilled and thin out too much when hot. The following definitions of viscosity are used in petroleum laboratories.
Viscosity Absolute	The force which will move 1 square centimeter of plane surface with a speed of 1 centimeter per second relative to another parallel plane surface from which it is separated by a layer of the liquid 1 centimeter thick. This viscosity is expressed in dynes per square centimeter, its unit being the poise, which is equal to 1 dyne-second per square centimeter. A unit of one-hundredth of a poise, designated as a centipoise, is of more convenient magnitude, and is commonly used.
Viscosity, Kinematic	The kinematic viscosity is defined as the absolute viscosity divided by the density at the temperature of the viscosity measurement. The metric units of kinematic viscosity are the stoke and centistoke, which correspond to the poise and centipoise of absolute viscosity.
Viscosity, Saybolt Furol	A viscosity test similar in nature to the Saybolt Universal viscosity test, but one more appropriate for testing high-viscosity oils. Certain transmission and gear oils and heavy fuel oils are rated by this method. The results obtained are approximately one-tenth the viscosity which would be shown by the Saybolt Universal method.
Viscosity, Saybolt Universal	The time, in seconds, for 60 milliliters of fluid to flow through a capillary tube in a Saybolt viscosimeter under specified conditions.
Viscous	Heavy, thick-bodied, gluey, or slow in motion.
Volatile	Tending to evaporate or vaporize readily; volatility is the extent to which a liquid vaporizes or the ease with which it turns to vapor.
Volute	The cavity of increasing volume into which the impeller of a centrifugal pump discharges and in which velocity head is converted to pressure head.
Water	An odorless, colorless, transparent liquid compound, H_2O. Water in fuels is described as follows.

Water, Dissolved	All fuel will contain water in solution but the amount will vary considerably as the temperature of the fuel varies. A rule-of-thumb estimate of the amount can be made by stating that the water-saturation value of the fuel is equal to PPM (parts per million) by volume to the fuel temperature in degrees Fahrenheit. This water cannot be separated from fuel by filtration or by mechanical means.
Water, Entrained	"Free" water which is suspended throughout a fuel sample and has not settled to the bottom of the container is considered "entrained" water.
Weathering	Loss of the most volatile components of crude oils and light products during storage and handling, and the formation of products of oxidation.

BULK FUEL MAN

Review Lesson

Instructions: This review lesson is designed to aid you in preparing for your final examination. You should try to complete this lesson without the aid of reference materials, but if you do not know an answer, look it up and remember what it is. The enclosed answer sheet must be filled out according to the instructions on its reverse side and mailed to MCI using the envelope provided. The questions you miss will be listed with references on a feedback sheet (MCI-R69) which will be mailed to your commanding officer with your final examination. You should study the reference material for the questions you missed before taking the final examination.

A. Multiple Choice: Select the ONE answer which BEST completes the statement or answers the question. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

1. The 50-gpm pump can fuel two vehicles with a maximum suction lift of up to

a. 10 feet.
b. 15 feet.
c. 25 feet.
d. 100 feet.

2. As an alternate pump in the Helicopter Expedient Refueling System, the 100-gpm pump delivers a suction lift of ________________ feet.

a. 10
b. 15
c. 20
d. 25

3. The 350-gpm pump delivers fuel at a rate of approximately ______ pounds per square inch.

a. 60
b. 80
c. 125
d. 200

4. The 350-gpm pump is equipped with 5 gate valves; _______ are suction and ______ is/are discharge.

a. 2, 3
b. 3, 2
c. 4, 1
d. 5, 0

5. The 600-gpm pump is designed to pump gasoline, jet fuel, diesel fuel, water, and

a. oil.
b. crude petroleum.
c. light liquid petroleum fuels.
d. waste.

6. A suction hose has four weaknesses. It is noncollapsible, it cannot be coiled, it has excessive weight, and it

a. has excessive length.
b. is available in only one size.
c. is not designed for positive pressure.
d. is not designed for negative pressure.

7. Four- and six-inch discharge hoses come in _______ foot lengths.

a. 25
b. 35
c. 45
d. 50

8. The action that causes a tight seal between hoses is known as _______________ action.

a. hose
b. fitting
c. cam
d. coupling

9. In the event of high vacuum, the discharge hose will

a. explode.
b. bulge.
c. collapse.
d. crack.

10. The two functions of the 50-gpm filter-separator are to perform a coalescing action and to filter out

a. water.
b. oil.
c. contaminants.
d. bacteria.

11. The unit on the 50-gpm filter-separator that shuts off the fuel flow when the water filtering capability is exceeded is called the

a. flow control valve.
b. site gage.
c. fuel quality monitor.
d. pressure gage.

12. The 100-gpm filter-separator is designed to filter and separate particles of ________ and _________ from light fuels.

a. oil, dirt
b. water, air
c. contamination, water
d. contamination, oil

13. The maximum working pressure of the 100-gpm filter-separator is

a. 125 psi.
b. 75 psi.
c. 50 psi.
d. 35 psi.

14. In the 350-gpm filter-separator, plasticized cellulose is used to block the passage of

a. water.
b. air.
c. contaminants.
d. sand.

15. Recirculation of fuel is done to remove impurities such as those from __________ products that include ______________ fibers.

a. cotton, cotton
b. rubber, gum
c. cellulose, gum
d. rubber, cotton

16. The purpose of the go-no-go is to remove solids and water, but more importantly it acts as a(n)

a. filter-separator.
b. manifold.
c. fuel cleanliness monitor.
d. hose coupling.

17. When the GO-NO-GO shuts down the fuel flow, this indicates that the

a. manifold is not operating properly.
b. filter separator is not operating properly.
c. hose coupling is defective.
d. fuel monitor is not operating properly.

18. The flow rate capability of the meter/register assembly ranges between 50 and ________ gpm.

a. 100
b. 250
c. 350
d. 650

19. Pressure regulators are issued in one size:

a. 2-inches.
b. 4-inches.
c. 6-inches.
d. 8-inches.

20. The primary purpose of the pressure regulator is to limit line pressures on

a. flat spaces.
b. uphill grades.
c. downhill grades.
d. underwater areas.

21. What valve on the preesure regulator can be adjusted within a range of 30 to 110 psi?

a. Discharge valve
b. Reducing valve
c. 3-way valve
d. Gate valve

B. Matching: Column 1 (items 22-25) lists four manifold assemblies. Column 2 (a through d) lists identifying characteristics of each of the four assemblies. Match each manifold assembly in column 1 with its identifying characteristic in column 2. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

Column 1 Manifold Assembly	Column 2 Characteristic
22. 4-inch manifold	a. 6 gate valves
23. 6-inch manifold	b. 2-inch suction lines
24. Drum unloading manifold	c. 2-inch dispensing hose
25. Fuel dispensing manifold	d. 5 or 6 gate valves

C. Multiple Choice: Select the ONE answer which BEST completes the statement or answers the question. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

26. When the 20,000-gallon collapsible tank is full, the top of the tank rests on the fuel. This is known as the

a. top float method.
b. floating top principle.
c. elliptical principle.
d. floated top method.

27. The three main physical features of the 20,000-gallon tank are the inlet, outlets, and

a. hoses.
b. ground cloth.
c. vent.
d. berm.

28. The number of 500-gallon fuel drums used in the HERS is

a. 6.
b. 12.
c. 15.
d. 18.

29. How is the elbow coupler valve different from other gate valves?

a. Its valves remain closed.
b. Its functions opposite of other valves.
c. You push to turn it off.
d. You pull to turn it off.

30. The emergency repair kit is furnished with patches, gaskets, and

a. bolts.
b. adapters.
c. clamps.
d. plugs.

31. The general repair kit includes fuel hose evacuation kits for _____ and _____ inch hoses.

a. 2, 4
b. 2, 6
c. 4, 6
d. 3, 6

32. Two types of fuel nozzles are gravity flow and

a. quick release.
b. service station.
c. pressure.
d. adapter.

33. The purpose of the liquid sight indicator is to

a. act as a fuel cleanliness monitor.
b. control the flow of fuel.
c. indicate the flow of fuel.
d. filter out sand and rust.

34. What is the purpose of the basket strainer assembly?

a. To regulate fuel flow
b. To indicate the flow of fuel
c. To constrict fuel flow
d. To remove sand and rust from fuel flow

35. The purpose of the wye couplings is to facilitate connections between suction and

a. discharge transfer lines.
b. suction transfer lines.
c. the tank farm.
d. over the beach assembly.

36. Two types of unloading units are the drum unloading unit and the

a. beach unloading station.
b. bulk tank unloading unit.
c. system unloading unit.
d. booster station.

37. The amount of separation between the booster station tanks is

a. 100 feet.
b. 120 feet.
c. 150 feet.
d. 175 feet.

38. The three duties of the "line walker" are to inspect lines for leaks, report any incidents that occur, and

a. perform repairs.
b. perform preventive maintenance.
c. guard lines from the enemy.
d. remove debris.

39. The tank farm site has four factors that must be considered. They are: accessibility to roads, ease in dispensing fuel, equipment dispersed, and

a. fuel replenishment.
b. natural camouflage.
c. contour of the terrain.
d. ease in berm preparation.

40. Two factors in berm design are confining fuel to the smallest possible area and separating berms in order to

a. allow space for more equipment.
b. ease dispensing requirements.
c. eliminate tanks from igniting each other.
d. allow for ease in camouflage.

41. Three characteristics of the berm are a 950 square foot burning surface, a 40,500 gallon volume, and _____ foot inside height and ____ foot outside height.

a. 6, 4
b. 6, 3
c. 4, 3
d. 3, 4

42. Two designs of tank farm construction are parallel rows of three and

a. vertical.
b. layered.
c. horizontal.
d. radial.

43. The primary mission of the AAFS is to supply class III and (A) to elements of the

a. Marine Brigade.
b. Marine Air Wing.
c. Marine Division.
d. Air Ground Task Force.

44. The total fuel capacity of the AAFS is

a. 500,000 gallons.
b. 610,000 gallons.
c. 720,000 gallons.
d. 800,000 gallons.

45. Two parent units of the THFDS are the Marine Air Base Squadrons and the

a. Marine Wing Headquarters Squadron.
b. Marine Air Control Squadron.
c. Marine Wing Support Group.
d. Marine Division.

46. The TAFDS is capable of refueling up to ______ aircraft at one time.

a. 8
b. 12
c. 18
d. 20

47. The 50-gpm pump should not be used to refuel the Harrier because of its

a. size.
b. power.
c. flow rate.
d. static discharge.

48. What is the main characteristic of the high speed fixed refueling system?

a. Its equipment is deployable.
b. Its equipment is permanently mounted.
c. All systems are exactly alike.
d. Its equipment is easily transported.

49. The Expedient Refueler Assembly is a separate system yet resembles components of the

a. TAFDS.
b. HERS.
c. fixed system.
d. AAFS.

50. The floating line method of transferring fuel consists of 250-foot lengths of _____________________________ hose.

a. 6-inch discharge
b. 6-inch suction
c. 4-inch discharge
d. 4-inch suction

51. The bottom-laid method of transferring fuel from ship to shore consists of 30-foot sections of ________________________ line.

a. 4-inch discharge
b. 4-inch submarine
c. 6-inch discharge
d. 6-inch submarine

52. The four processes of reclamation are downgrading, blending, purification, and

a. mixing.
b. inhibiting.
c. filtering.
d. dehydration.

53. The four methods of disposal of unfit fuel in tactical situations are burning, burying, transfering, and

a. mixing.
b. blending.
c. dehydration.
d. downgrading.

54. Quality control is the responsibility of

a. the company commander.
b. the platoon commander.
c. the platoon sergeant.
d. all bulk fuel men.

55. Where does the greatest danger of products becoming mixed exist?

a. In the hoses
b. In the collapsible tanks
c. In the tanker truck
d. In the tanker compartments

56. Gum may be maintained within acceptable limits by

a. filtering.
b. mixing.
c. purification.
d. recirculation.

57. The recirculation time for 1300 feet of 4-inch line is

a. 10 minutes.
b. 13 minutes.
c. 14 minutes.
d. 16 minutes.

58. The recirculation time for 1800 feet of 2-inch line is

a. 4 minutes.
b. 7 minutes.
c. 9 minutes.
d. 11 minutes.

59. Recirculation, to prevent gum buildup, must be employed when fuel has _______________, for a period of 24 hours or more.

a. been moving
b. been turbulent
c. laid dormant
d. been mixed

60. A true sample of the fuel being dispersed must be taken from the

a. tank.
b. hoses.
c. filter-separator.
d. nozzle.

R. Matching: Column 1 (items 61-64) lists 5 types of fuel and column 2 lists 5 colors of fuel. Match each type of fuel in column 1 with its color in column 2. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

Column 1 Fuel	Column 2 Color
61. DR II	a. Blue
62. 91/96	b. Purple
63. 115/145	c. Red
64. Mogas	d. Straw

S. Multiple Choice: Select the ONE answer that BEST completes the statement or answers the question. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

65. A sample can be defined as a small amount of product that is representative to five of

a. contaminated fuel.
b. a small portion of product.
c. the whole quantity.
d. a product in the line.

66. "Table 5" refers to API and ______ values that are correctable to 60^{0}.

a. APLO
b. ATSM
c. APE
d. ASTM

67. When you receive fuel, the API quality reading should not vary from the ______________ ______________ of degrees more than 5.

a. established number
b. specific reading
c. gravity weight
d. element number

68. The test that applies to aviation gas only is

a. the closed cup flashpoint.
b. copper corrosion.
c. the copper dish gum.
d. distillation.

69. The test that shows sediment and water in the product using only the __________________ is the visual or appearance.

a. drum thief
b. clean nozzle
c. clear beaker
d. distillation unit

70. Gases and vapors are divided into four groups depending on whether they are poisonous, asphyxiants, anesthetics, or

a. flammables.
b. irritants.
c. toxic.
d. infective.

71. If a Marine swallows flammable liquids, you should keep him calm, have him drink 1/2 canteen of water or milk to dilute the fuel and

a. induce vomiting.
b. get medical aid.
c. loosen his clothing.
d. flush his skin with water.

72. When you are working in the fuel farm with electrical equipment, you should ensure that the equipment is

a. shock proof.
b. clean.
c. explosion proof.
d. 150 feet from the tanks.

73. The greatest single cause of common fires is

a. poor housekeeping.
b. electrical shorts.
c. smoking (and matches).
d. static electricity.

74. A fire is a combustion between three things: fuel, heat, and

a. gasoline.
b. chemicals.
c. igniting action.
d. oxygen.

75. A Class A fire is a fire that is a(n)

a. gasoline fire.
b. burnable metal fire.
c. wood fire.
d. electrical fire.

76. When fully charged with nitrogen and purple "K" powder, the ____________________ will deliver the chemical agent through the hose for a period of 86 to 104 seconds and a range of 35 feet.

a. twin-agent unit
b. 150-pound extinguisher
c. firefighting truck
d. 30-pound extinguisher

77. The chemical composition of ________________ is a dry potassium powder.

a. nitrogen
b. purple "K"
c. carbon dioxide
d. chalk

78. The 30-pound fire extinguisher has a fan-shaped pattern with a(n) ____________ second operation.

a. 8-12
b. 10-15
c. 11-20
d. 18-30

79. The 150-pound fire extinguisher has a 35 foot range for a period of about

a. 2 minutes.
b. one minute.
c. 45-60 seconds.
d. 35 seconds.

80. The Twin-Agent Unit can provide firefighting capabilities to a six-tank farm with the use of the 150-foot

a. hose.
b. remote hose reel.
c. extension.
d. discharge lines.

81. The Twin-Agent Unit has a range of ___________ feet.

a. 40-50
b. 17
c. 35
d. 30-40

82. The TAU consists of two completely independent systems: the AFFF and

a. carbon dioxide.
b. nitrogen.
c. dry chemical.
d. aqueous foam.

83. The three-dimensional fire consists of a

a. fire with obstacles.
b. fire that requires maximum effort.
c. pan or pit fire.

Total Points: 83

* * *

TAE-1

STUDENT COURSE CONTENT ASSISTANCE REQUEST

DATE:

COURSE NUMBER　　COURSE TITLE

NAME　　RANK　　MOS

SOCIAL SECURITY NUMBER

1. Use this form for any questions you may have about the course. Write out your question and refer to the study unit, work unit, or study question with which you are having problems. Complete the self-addressed block on the reverse side. Before mailing, fold the form and staple it so that MCI's address is showing. Additional sheets may be attached to this side of the form.

MY QUESTION IS:	OUR ANSWER IS:

SIGNATURE (TITLE OR RANK)

STUDENT: Detach and retain this portion.

DATA REQUIRED BY THE PRIVACY ACT OF 1974
(5 U.S.C. 522A)

1. AUTHORITY: Title 5, USC, Sec. 301. Use of your Social Security Number is authorized by Executive Order 9397 of 22 Nov 43.

2. PRINCIPAL PURPOSE: The Student Course Content Assistance Request is used to transmit information concerning student participation in MCI courses.

3. ROUTINE USE: This information is used by MCI personnel to research student inquiries. In some cases information contained therein is used to update correspondence courses and individual student records maintained by the Marine Corps Institute.

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COURSE IMPROVEMENT SURVEY

The Marine Corps Institute would appreciate your help in improving the course you have just completed. If you would take a few minutes to complete the following survey, we would have valuable information to help us improve this course. Your answers will be kept confidential and will in no way affect your grade.

Course Number ☐ Rank__________ MOS__________

Name (Optional) ____________________

Military Address (Optional) ____________________

1. Did you find inaccurate or outdated information in this course? ☐ Yes ☐ No

   List the areas you found inaccurate or out of date. Give page or paragraph if possible.

2. How long did it take you to finish the course?

   ☐ 1-5 hours ☐ 11-15 hours ☐ More than 20 hours
   ☐ 6-10 hours ☐ 16-20 hours

3. Were the procedures taught in this course understandable and useful? ☐ Yes ☐ No

   If "No," how could they be improved? ____________________

4. How much of the material taught in this course can you apply to your job?

   ☐ Almost all ☐ Very little ☐ None
   ☐ More than half ☐ Less than half

5. Did you have trouble reading or understanding the material in this course? ☐ Yes ☐ No

   If "Yes,", explain____________________

6. Were the illustrations in this course helpful? ☐ Yes ☐ No

   If "No," how could they be improved?____________________

7. Put an "X" in a box on the scale below to show how well you feel the lessons and the course materials prepared you for the final examination. (On this scale "10" indicates that the material prepared you very well, a "5" indicates adequate preparation, and a "1" indicates very poor preparation.)

   Very Poor Adequate Very Well

1	2	3	4	5	6	7	8	9	10

8. If you asked MCI for help, were the answers to your questions helpful?

   ☐ Yes ☐ No ☐ No questions sent to MCI

9. Please list below any suggestions you may have to improve this course. Try to be specific; give page or paragraph numbers. (You may also use the space on the back or attach additional sheets.)

T&E-19

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MARINE CORPS INSTITUTE

BULK FUEL MAN

HANDBOOK

MARINE BARRACKS
WASHINGTON, D.C.

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1. History. During World War II, the fuel demands of the Marine division in the assault placed a heavy burden on the fuel handling facilities of the shore party. With 5-gallon cans and 55 gallon drums, the minimum fuel requirements were barely met. The Commandant of the Marine Corps directed the Marine Corps equipment board to establish a project for delivering fuel during amphibious operations. The concept of this method was developed by the Marine Corps and proposed in 1952. The development of the amphibious assault fuel system has progressed gradually into its present form.

2. Mission of Amphibious Assault Fuel System (AAFS). The primary mission of the AAFS is to supply class III and III (A) fuel to elements of the air-ground task force, to include distribution to, but not within air bases, to assure that class III (A) products distributed to supported air bases are the required type, quality and purity.

3. Employment. The AAFS is employed to receive fuel over the beach for storage and use ashore. The major assemblies of the AAFS are one beach unloading assembly, two fuel dispensing assemblies and one drum unloading assembly. Fuel is stored temporarily and can be transferred to another storage site or dispensed to individual containers, vehicles, tank trucks, or aircraft. The basic capacity of the AAFS is 600,000 gallons, made of five 120,000 gallon tank farms. The total storage capacity would be 720,000 gallons, including two booster pump assemblies and one beach unloading assembly. The AAFS system can be tailored to increase or decrease capacity by adding or deleting tanks and accessories.

4. Installation

Each major component is constructed in such a way that it may be installed without the use of special tools.

A complete system can be ready for operation in 48 to 72 hours after the initial assault.

Each major component is capable of functioning continuously, with proper care and maintenance, for a period of 45 days or more without replacement.

5. Site Selection

The terrain is the most important factor when installation of an AAFS is set up.

When fuel transfer operations are carried out in very hilly terrain, the booster pump assemblies may be only 50 to 100 meters apart.

The terrain must accommodate amphibious craft.

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6. Discription of Components

- Collapsible Tank. Each system has 36 collapsible tanks constructed of impregnated fabric with filler and discharge assemblies. Each collapsible tank has a capacity of 20,000 gallons, and has a ground cloth appropriate to the size and shape of the tank and fitted with hand straps. The ground cloth is installed under the tank for protection from sharp rocks or other protrusions. Each tank will have its own light weight metal tank chest, for transporting collapsible tank, fittings, ground cloth, and a emergency repair kit. The chest is equipped with carrying handles, lifting hooks, towing eyes, and forklift cutouts, for movement by hand or heavy equipment.

- Hoses. There are two type of hoses supplied for the AAFS. The suction hose is wire reinforced to prevent collapse under high vacuum and is not intended to withstand high positive pressure. The discharge hose will collapse under vacuum but will withstand operating pressure of up to 125 (PSI's) pounds per square inch. Each section of hose is equipped with a quick-disconnect adapter (male) at one end and a quick-disconnect coupler (female) at the other end. Such hose comes in 2-inch and 4-inch sections, and discharge hoses comes in 2-inch, 4-inch and 6-inch sections.

- Pump. The 600 GPM pump is the standard pump for the AAFS system. The trailer-mounted, self priming, centrifugal pump is a self-contained unit for pumping gasolines, jet fuels, and diesel fuels. The 600-GPM pump is diesel-driven, with suction and discharge sides each having two 4-inch and one 6-inch ports.

- Meter Assemblies. The AAFS has 3-inch and 2-inch skid mounted meter assemblies provided to measure the amount of fuel delivered. The 3-inch meter has fittings to permit installation into a 4-inch hose line. This meter registers flow rates from 50 to 650 GPM at a maximum pressure of 200 psi. It has a register that can be reset for each individual operation and a cumulative read out. The 2-inch meter registers flow rates from 25 to 250 GPM and the meter can be reset in order to register each delivery.

- Pressure Regulator. The pressure regulator is used to control excessive pressure in the fuel transfer lines. Its main use is in the down grade side of steep terrain between two pumping stations or between a pumping station and a tank farm.

- Filter Separator. This assembly is a self-contained, skid mounted unit, which is of a vertical type design and aluminum construction, designed to remove solids and undissolved water from light petroleum fuels.

- Fuel Monitor. The fuel monitor is installed down stream of the filter separator to monitor the solid contaminants and undissolved water in fuel being dispensed. If the contaminants or water exceed a safe level, the monitor will shut off all flow. During normal operations the fuel monitor has a maximum operation of 400 GPM with clean fuses.

- **Strainer.** The 6-inch strainer is designed to remove large particles of contamination, such as sand or rust, from fuels as they are pumped ashore. This design allows for cleaning one side of the strainer while fuel continues to flow at a reduced rate on the other side.

- **Manifolds and Fittings**

Drum Unloading Valve. The drum unloading valve is used with the drum unloading manifold to empty 55 gallon drums or 5 gallon cans into collapsible tanks. The drum unloading manifold has one 4-inch male adapter and three 2-inch female couplers.

Fuel Dispensing Manifold. The fuel dispensing manifold is designed to be connected to a 4 inch discharge hose to feed three 2-inch discharge hoses connected to fuel nozzles. The fuel dispensing manifold has one 4-inch female fitting and three 2-inch male fittings.

Skid Mounted Manifolds. There are two sizes of skid mounted manifolds, 4-inch and 6-inch in an AAFS. The manifolds are equipped with either five (two inlet, three discharge) or six (three inlet, three discharge) ports. The primary use of the manifolds is in fuel distribution to tanks and in recirculation of fuel.

Wye fittings. There are two types of wye fittings that are provided to make connectors for various functions in an AAFS. One type has one adapter and two couplers (ACC), and the other has one coupler and two adapters (CAA).

Sight Indicators. The AAFS includes 2-inch and 6-inch sight indicators which are inserted in the appropriate size hose lines to indicate fuel flow by vane movement.

Reducers. For ease in interconnecting 6-inch and 4-inch segments of the fuel system, reducers are furnished. One type (6C x 4A) has a 6 inch coupler with a 4-inch adapter. The other (4C x 6A) has a 4-inch coupler with a 6-inch adapter.

Flanged Adapters. The AAFS is provided with 4-inch quick disconnect adapters with 3-4-6-and 8-inch flanges for connection to off shore fuel sources.

- **Fuel Servicing Gravity Nozzle.** The fuel servicing nozzle is used to dispense fuel to vehicles and individual containers. A nozzle stand is furnished for use at dispensing points to keep nozzles from picking up contamination when not in use.

- **Nestable Pipe Culvert.** The nestable pipe culvert is made from 2 feet lengths of currugated galvanized steel half sections, 10 inches in diameter. A total of 120 liner feet of culvert is included in each AAFS system, to provide a protected path under roads or in other places where vehicular traffic could damage the hose.

- General Repair Kit. The general repair kit contains spare parts, gaskets, gages and a limited number of tools for the routine maintenance, replacement, and repair of individual components in the fuel system. The kit is contained in three chests that are similar to, but smaller than the tank chest. The general repair kit is in addition to the emergency tank repair kit furnished with each tank; the two should not be confused.

- Valves. The hand operated valves in the system are of the rising stem type, of standard design, and made from anodized aluminum alloy. Gate valves with couplers and adapters in 4-inch and 6-inch sizes are in the AAFS.

7. Fire Extinguishers

FireFighting Truck, MCI-1051. Its used to combat fires in fuel installations. It is a dry chemical firefighting vehicle that uses "purple K powder," a dry potassium chemical, which is delivered under pressure, by means of two 50 feet hoses, at a range of 35 feet beyond the nozzle. It also has two, hand-portable dry chemical fire extinguishers that are brackets located on the front bumper.

Twin Agent Skid Mounted. This fire extinguisher is designed and constructed to be particularly effective in fighting fires generated by hydrocarbon fuels. It is intended for use in providing fire protection to the AAFS. It uses both chemicals and aqueous film foaming foam. These twin agents are stored in containers on the extinguisher. A remote hose cart is provided with the unit.

Thirty Pound Hand Type. The 30 lb. extinguisher is used to fight small fires in localized areas, such as engine or gasoline spills. It has a range of 17 feet and will operate for 8 to 12 seconds.

8. Protective Clothing

Successful extinction of fires within berms requires a close in location for the fire extinguisher operators. This is necessary because of the limited range of the fire extinguishers and the limited quantities that they provide. This closeness to the fire makes it essential that Marines wear suitable protective clothing. This clothing is available in the following:

Hood, Firemans, Aluminized, Proximity
Coat, Firemans, Aluminized, Proximity
Trousers, Firemans, Aluminized, Proximity
Coveralls, Firemans, Aluminized, Proximity
Boots, Firemans, Cold Weather
Gloves, Firemans, Aluminized, Proximity

1. A Brief History of Tactical Airfield Fuel Dispensing System (TAFDS) and Helicopter Expedient Refueling System (HERS)

a. During World War II, fuel and petroleum related products comprised between 55 and 60 percent of all supplies shipped overseas. During the Korean War this percentage had increased to 73 percent. The fuel needs of the Marine Amphibious Forces were barely met with 5 gallon cans and 55 gallon drums. At the direction of the Commandant. The Marine Corps developed a concept in 1952 for fuel delivery in amphibious operations. This concept proved workable and evolved into the Amphibious Assault Fuel System (AAFS), the Tactical Airfield Fuel Dispensing System (TAFDS), and the Helicopter Expedient Refueling System (HERS).

b. During the Vietnam conflict, these systems were combat tested from the 17th parallel south to the Mekong Delta and were successful. The majority of fuel issued to Marine Corps units was issued through either AAFS or TAFDS. The AAFS fuel farm at Chu Lai consisted of 120 10,000 gallon fuel tanks or 1,200,000 gallons of gasoline, diesel fuel, aviation gasoline, and JP-5 jet fuel. This system operated from September 1965 until 1968 when the Navy installed rigid steel tanks and assumed responsibility for the operations.

c. Since 1973, when the Marine Corps left the Republic of Vietnam, the Marine Corps has improved and increased the capacity of the AAFS and the TAFDS.

2. The mission of TAFDS and HERS

a. The TAFDS and HERS mission is to receive, store, transfer, and dispense liquid aviation fuels in an approved quality to Marine aviation units. The TAFDS and HERS are not limited to aviation fuel and may provide tactical fuel support also.

b. The majority of aviation fuel will be provided to TAFDS and HERS from the Amphibious Assault Fuel System (AAFS).

c. The TAFDS is a fairly simple, versatile, air transportable aviation fuel dispensing system capable of receiving and storing up to 120,000 gallons of fuel and simultaneously dispensing fuel from 18 refueling stations in an ideal situation. The TAFDS can receive fuel from the AAFS or has the drum unloading capability.

d. The following is a list of the major components of a TAFDS and their basic function in the system.

1. Three 600/350-gpm pumps used to transfer fuel from the fuel tanks to the dispensing points.

2. Six 20,000 gallon rubber impregnated nylon tanks with chests used to store aviation fuels.

3. Six 350-gpm filter separators are used to insure that clean quality fuel is issued.

4. Six fuel monitors (go-no-go) assist the filter separator in maintaining the quality of the fuel issued.

5. One 4-inch manifold (spider) assembly, a skid mounted unit with either five or six gate valve controlled ports, used for fuel distribution and recirculation.

6. Three 3-inch meter register assemblies used to measure the amount of fuel issued or recirculated.

7. Twelve 2-inch meter register assemblies used to measure the amount of fuel issued at individual issue points.

8. Eight 2-inch x 25 foot suction hoses, used to remove fuel from 55 gallon drums.

9. Nineteen 4-inch x 25 foot suction hoses used to connect the tank to the pumps.

10. Thirty-six 2-inch x 25 foot discharge hoses used at the issue points.

11. Sixty 4-inch x 50 foot discharge hoses used at the main fuel line.

12. Thirty 4-inch hand operated gate valves to control flow of fuel within the sytem.

13. Twelve coupler coupler adapters (CCA) wyes and eight adapter adapter couplers (AAC) wyes used to make connections adapting two lines from one or one line into two.

14. Six fuel dispensing mainfolds used to divide the four inch main line into three 2-inch dispensing lines.

15. Eight drum unloading manifolds used to empty 55 gallon drums.

16. Eighteen pressure locking nozzles used to refuel aircraft.

17. Twelve (gravity flow) fuel servicing nozzles used to refuel drop tanks from aircraft.

18. One general repair kit, which consists of three chests of repair parts, clamps, couplings, gaskets, nozzles, pre-formed packing, and kits. These kits are the evacuation kit, used for purging fuel from the hoses, and the explosiometer gas indicator set, used to detect gas and explosive vapors. The general repair kit also contains plugs and clamps used in the repair of the collapsible tank.

19. Each system will have a nestable culvert to protect hoses, nozzle stands to elevate the nozzle from the ground, and individual tank repair kits. The system will have a number of other miscellaneous items that you will work with.

1. The purpose of the Helicopter Expedient Refueling System (HERS).

a. The HERS is an air transportable, modular, refueling system, capable of being set up without any special hand tools.

b. The HERS was initially designed to refuel helicopters at remote sites and locations. With the introduction of the AV-8 Harrier, the HERS has assumed the responsibility of providing fuel at any location from which this aircraft can operate.

c. The HERS will provide all the equipment necessary to refuel helicopters and V/STOL aircraft at remote locations and sites, at a rate of 50/100 gallons of fuel per minute.

2. Major components of the HERS and their basic functions.

1. Two 50-gpm or 100-gpm pumps which will be used to transfer fuel from the fuel drums to either helicopters or V/STOL aircraft.

2. Eighteen 500 gallon rubber impregnated fabric collapsible fuel drums, which can be used to transport and store aviation fuel.

3. Two 50-or 100-gpm filter separator fuel monitor assemblies which will be used to ensure only that specification fuel is issued to the aircraft.

4. Four 2-inch meter assemblies which will be used to measure the amount of fuel issued.

5. Twenty-four 2-inch x 10 foot suction hoses, used to connect the fuel drums to the pump.

6. Six 2-inch x 50 foot discharge hoses, used between the pump and the issue point.

7. Four fuel and oil nozzles (Standard gravity flow) and four pressure nozzles to enable the HERS to fill aviation and the capability to be used at a vehicle fueling system.

8. Four nozzle stands to elevate the nozzle from the ground to keep contamination away from the nozzle and the fuel.

9. Miscellaneous items such as couplers and adapters to enable quick connections between hoses.

1. Maintenance Categories

a. Organizational. Organizational maintenance is that which is the responsibility of and is performed by the using organization. It normally consists of inspecting, servicing, lubricating, adjusting and replacing parts, and minor assembly not requiring highly technical skills. It includes first echelon maintenance performed by the operator, and second echelon maintenance performed by specially trained personnel in the using organization.

b. Intermediate. Intermediate or field maintenance is maintenance authorized and performed by a designated maintenance activity in direct support of the using activity; third echelon by higher echelon maintenance units; fourth echelon supporting the direct support maintenance activity; and is normally limited to replacing parts and assemblies. Intermediate maintenance units also support using organizations with special assistance mobile field repair teams; and repair parts.

c. Depot. Depot maintenance is repair involving major overhaul or complete rebuilding of parts and assemblies of the end items. Depot maintenance is fifth echelon.

2. Maintenance Echelons

a. Organizational Maintenance

(1) First Echelon Maintenance. Is performed by the user, wearer, operator, or crew.

(2) Second Echelon Maintenance. Is performed by specially trained personnel in the using owning organization.

b. Intermediate Maintenance (Field Maintenance)

(1) Third Echelon Maintenance. Is performed in direct support (DS) of, and, in some cases, by using units and is limited by authorized tools, test equipment, and spare parts.

(2) Fourth Echelon Maintenance. Is usually performed in rear areas by units in general support. Normally, next higher organizational echelon than direct support unit, and is limited by authorized tools, test equipment, and spare parts. Also covers calibration.

c. Depot Maintenance. Fifth Echelon Maintenance is major overhaul or complete rebuild. The purpose of learning 1st, 2nd, and 3rd echelon maintenance is to know how to repair the pump, when you are in a field environment, where you would have to know the higher echelons of maintenance.

First Echelon Maintenance

1. First Echelon Maintenance is the action taken to keep material in a serviceable condition, and is the responsibility of every user, operator, or crew.

2. Performing First Echelon Maintenance

a. 600-GPM Pump

(1) Inspect the frame for cracks, broken welds, etc.

(2) Lubricate all grease fittings, oil all movable parts, and clean and grease battery terminals.

(3) Check for leaks from the gate valves and seals.

(4) Check the fluid levels--oils, battery electrolite, fuel, and radiator coolant. If any of these are low, fill to the full level.

(5) Inspect and tighten, as necessary, the battery connections and instrument panel connections.

(6) Inspect oil filters, air filters, and fuel filters; clean or replace if necessary.

(7) Tighten all loose nuts and bolts.

(8) Lights must be clean and working properly, especially if they are to be connected to a vehicle. Reflectors must be cleaned.

(9) Spot paint and clean the frame structure as necessary.

b. 350-GPM Pump

(1) Inspect the frame for cracks, broken welds, if any.

(2) Lubricate all grease fittings, oil all movable parts, and grease pintle hook.

(3) Check for leaks from the gate valves and seals.

(4) Check the oil level and fuel level; fill if required.

(5) Inspect oil filters, air filters, fuel filters. Clean or replace as necessary.

(6) Check spark plugs and ensure that the porcelain is not cracked and the wires are serviceable.

(7) Tighten all loose nuts and bolts.

(8) Spot paint and clean as necessary.

(9) The most important check you might make is to ensure that you have the starting crank.

c. Discharge Hose

(1) Check hoses for serviceable O-rings.

(2) The banding must be tight around the adapter and coupler ends. If it is loose the hose must be replaced or new banding installed.

(3) Check for cracks along the entire hose. If any cracks are encountered, the hose must be replaced.

(4) Camlocks must not be bent or broken.

(5) After fuel is in the hose, and if any seepage occurs, the hose must be replaced, or a fuel spill or fire could be the result.

(6) Prior to using a hose, ensure that it is free of all dirt and objects that could block the flow of fuel.

d. Suction Hose

(1) All procedures from paragraph c., above, regarding discharge hose apply to suction hose. Additionally, suction hose has steel wire mesh reinforcement. Therefore, when the hose is deformed, it must be replaced.

e. Filter Separator

(1) The frame must be thoroughly inspected for cracks and previous welds as the frame is aluminum and occassionally fails when handled.

(2) The filters must be checked before use. Determine when they were last changed and change if necessary. The installation data should be stenciled on the outside of the separator.

(3) The copper tubing must be inspected for cracks, holes, or kinks. If any discrepancies are discovered, they must be corrected before use.

(4) The sight glass should be clean and free of any loose material.

(5) All valves should turn freely and all nuts must be tightened.

(6) The drain valve must be tightened to prevent the loss of the fuel in the filter separator.

(7) All plugs and caps must be in place.

f. Fuel Monitor (Go-No-Go)

(1) The filter elements must be checked for previous use. The installation data should be stenciled on the outside of the monitor.

(2) The copper tubing must be inspected for cracks and leaks.

(3) The inlet and outlet gages must be checked for serviceability.

(4) The fuel monitor must be drained and cleaned prior to use.

(5) The frame must be inspected for cracks and broken welds.

g. Spider Manifold

(1) The gate valves must turn freely.

(2) The O-rings and gaskets must be inspected for serviceability.

(3) Plugs and caps must be in place.

(4) Spot paint and clean if needed.

h. Meters

(1) Inspect for cracks on frame. Replace if necessary.

(2) Meters must have caps and plugs.

(3) The adapter and coupler ends must be tight.

(4) The O-rings must be checked for serviceability.

i. Fire Extinguishers

(1) Twin Agent Unit (TAU)

(a) The frame structure must be inspected for cracks.

(b) The hose reel must be serviceable, with no cracks. The hose reel must turn freely.

(c) The pressure gages must have the required amount of pressure.

(d) The hoses must be serviceable, otherwise you will lose the pressure that is needed in an emergency situation.

(e) The PKP and light water must be at the full level.

(2) 150 pound fire extinguisher

(a) Hoses must be free of PKP that may be clogged due to moisture.

(b) The wheels must be oiled to ensure that they move freely.

(c) Gages must work; check for proper pressure.

(d) When checking the PKP, make sure you listen for air escaping from the small opening on top of the cap.

(3) 30 pound fire extinguisher

(a) Ensure that the level of PKP is correct.

(b) The cylinder must be sealed, with no holes.

(c) The hose must not have any cracks or holes.

(d) The nozzle should open and shut easily.

● FUEL CONTAMINATION AND QUALITY CONTROL ●

Fuel contamination occurs when two or more grades or types of fuel are mixed by accident, or the fuel contains foreign matter such as dust, dirt, rust, water, gum, or emulsions. Contaminated fuel can cause engines of all types to malfunction. This reduces operational readiness and can result in injuries or death, as in the case of aircraft engine failure.

Quality control is the term used to describe the measures taken, tests made, and devices used to make sure the fuel is of a usable quality.

The quickest test to be made for quality control is the Appearance Test. The fuel should be clean, bright, and free of visible particles. The visual check allows for checks on the color to ascertain the types of fuel as shown in the table below.

Grade (use)	NATO symbol	Color
80/87 (MOGAS)	F-12	Red
100/130 (AVGAS)	F-18	Green
115/145 (AVGAS)	F-22	Purple
JP-4 (Jet B)	F-40	Clear to straw
JP-5 (Jet A, A-1)	F-44	Clear to straw

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● Cloudiness indicates that water is present; the visible foreign matter is sediment. The contaminants and their effects are shown in the next table.

● To make this test, use a clean container such as a glass beaker, drum thief, or an object that you are sure is free from contamination. Take a sample from the nozzle or from a part of the tank that is distant from the inlet to the tank. Swirl the sample in the container to form a whirlpool. Sediment in the sample will accumulate directly under the whirlpool. Sediment limits are shown at the end of the next table. Particles or sediment in the sample indicate improper filter separator operation or possibly a source of contamination within the system. Check the system and replace the defective part.

● Clouds in the sample are finely divided water or emulsion. Usually, this means the filter-separator is operating improperly. Check the system and replace the faulty part. Acceptable limits of water allowed are shown following the next table.

Type contaminants	Appearance	Characteristics	Effects
Water: Dissolved water	Not visible.	Fresh water only. Precipitates out as cloud when fuel is cooled.	None, unless separated by cooling of fuel; then acts as free water.
Free water	Light or heavy cloud; droplets cling to sides of bottle, or large amounts on bottom.	Salt water or fresh water.	Icing of fuel system; erratic fuel gage readings; large amounts can cause flameouts; salt water corrodes components.
Sediment: Rust	Red or black powder, rouge, or grains; may appear as dye-like material in fuel.	Red rust (Fe_2O_3) nonmagnetic; black rust (Fe_3O_4) magnetic; rust generally comprises 70-90 percent of total sediment.	Causes sticking, sluggish or general malfunction of fuel controls, flow dividers, pumps, nozzles, etc.
Sand or dust	Crystalline, granular or glass-like.	Usually 0-20 percent of total sediment.	Same as rust.
Sediment: - Continued Aluminum, cadmium, or magnesium.	White or gray powder or paste.	Sometimes sticky or gelatinous when wet; usually 0-10 percent of total sediment.	Same as rust, and may lower flight range and high attitude performance.
Emulsions: Water in fuel	Light or heavy cloud.	Finely divided drops of water in fuel; same as free water cloud; will settle to bottom in minutes, hours, or weeks, depending upon nature of emulsion.	Same as free water.
Fuel in water	Reddish, grayish, or blackish; sticky material described as gelatinous, gummy, or "mayonnaiselike"; may appear as "globules" or stringy, fibrous material in clear or cloudy fuel.	Finely divided drops of fuel in water; contain rust which stabilizes or "firms" the emulsion; sticks to most materials normally in contact with fuels; may stand from days to months without seperating; contains 50-70 percent water and 30-50 percent fuel.	Same as free water and sediment, but worse; causes filter plugging and erratic readings in fuel quantity probes.
Miscellaneous: Interface matter	Lacy bubbles or scum at interface between fuel and water; resembles jellyfish.	Caused by bacteria acting on chemicals in fresh water; may have "rotten egg" smell.	Same as free water; may leave deposits in fuel tanks.
Air bubbles	Cloud in fuel.	Disperse upward within a few seconds.	None.

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Contamination Table

Type contaminants	Appearance	Characteristics	Effects on aircraft or engines
Water:			
Dissolved water	Not visible.	Fresh water only. Precipitates out as cloud when fuel is cooled.	None, unless separated by cooling of fuel; then acts as free water.
Free water	Light or heavy cloud; droplets cling to sides of bottle, or large amounts on bottom.	Salt water or fresh water.	Icing of fuel system; erratic fuel gage readings; large amounts can cause flameouts; salt water corrodes components.
Sediment:			
Rust	Red or black powder, rouge, or grains; may appear as dye-like material in fuel.	Red rust (Fe_2O_3) nonmagnetic; black rust (Fe_3O_4) magnetic; rust generally comprises 70-90 percent of total sediment.	Causes sticking, sluggish or general malfunction of fuel controls, flow dividers, pumps, nozzles, etc.
Sand or dust	Crystalline, granular or glass-like.	Usually 0-20 percent of total sediment.	Same as rust.
Alumina, cadmium magnesium	White or gray powder or paste.	Sometimes sticky or gelatinous when wet; usually 0-10 percent of total sediment.	Same as rust, and may lower flight range and high attitude performance.
Emulsions:			
Water in fuel	Light or heavy cloud.	Finely divided drops of water in fuel; same as free water cloud; will settle to bottom in minutes, hours, or weeks, depending upon nature of emulsion.	Same as free water.
Fuel in water	Reddish, grayish, or blackish; sticky material described as gelatinous, gummy, or "mayonnaise like"; may appear as "globules" or stringy, fibrous material in clear or cloudy fuel.	Finely divided drops of fuel in water; contain rust which stabilizes or "firms" the emulsion; sticks to most materials normally in contact with fuels; may stand from days to months without separating; contains 50-70 percent water and 30-50 percent fuel.	Same as free water and sediment, but worse; causes filter plugging and erratic readings in fuel quantity probes.
Miscellaneous:			
Interface matter	Lacy bubbles or scum at interface between fuel and water; resembles	Caused by bacteria acting on chemicals in fresh water; may have "rotten egg" smell.	Same as free water; may leave deposits in in fuel tanks.
Air bubbles	Cloud in fuel.	Disperses upward within a few seconds.	None.

Sediment Contamination Limits

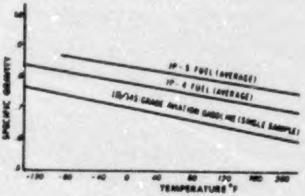
Sediment (mg/liter)	Fuel quality	Fuel system reliability	Acceptability
0.0 - 1.0	Clean	Excellent	Yes
1.0 - 2.0	Slight contamination	Good	Yes
2.0 - 5.0	Moderate contamination	Fair	Marginal
5.0 - 10.0	Heavy contamination	Poor	No
10.0 - plus	Gross contamination	None	No

Water Contamination Limits

Form of water	Amount of water (ml/liter)	Acceptability
None	0.00	Yes
Detectable visually	0.00 - 0.005	Yes
Trace	0.005 - 0.02	No
Light to heavy cloud	0.02 - 0.03	No
Heavy cloud	0.03 plus	No
Settled water	0.05 plus	No

Any evidence of microbiological growth requires stopping fueling operations and notifying the fuel control officer.

The specific gravity of a fluid is the weight of a given volume of the fluid compared to the weight of an equal volume of water at the same temperature. Water is assigned a specific gravity of 1.00, so a liquid lighter than water will have a specific gravity less than 1.00, and a liquid heavier than water will have a specific gravity of more than 1.00. As liquids are heated, they expand so that the same weight of liquid takes up more volume, and the specific gravity goes down. This change of specific gravity with temperature for various fuels is shown below. Since meaningful differences in fuels exist, specific gravities may extend out to four decimal places.



Variation of Specific Gravity With Temperature

Hence the API (American Petroleum Institute) developed a scale called degrees API gravity, which is easier to use with fuels. The relationship is expressed as follows:

$$\text{Degrees API} = \frac{141.3}{\text{Specific Gravity}} - 131.5$$

or

$$\text{Specific Gravity} = \frac{141.5}{131.5 + \text{degrees API}}$$

It can be seen that a fuel of 10° API gravity has a specific gravity of 1.00, or is the same as water.

To make the gravity test:

Collect a fuel sample from a nozzle spout into a clean tall container so that there is enough fluid to float the hydrometer (about 150 milliliters or 1/3 pint).

Place a hydrometer with the proper scale for the fuel being tested into the hydrometer cylinder, and pour in the fuel sample until the hydrometer floats clear of the cylinder bottom. Record the degree API reading on the hydrometer scale. Record the temperature of the fuel.

The degree API reading should be compared with the reading recorded when the particular batch of fuel was last transferred. If this cannot be done, compare the sample reading with the degree API readings of samples that have been collected at regular intervals from the same fuel batch. This will insure detection of any change in specific gravity during storage or during dispensing operations.

Fuel received from tanks which handle several fuel types should be very carefully checked with a hydrometer. Fuel received from depot or refinery-sealed containers, such as drums or tank cars, is less likely to have been mixed with other fuel types, but should be hydrometer-checked as a matter of course.

The degrees API generally should not differ by more than 0.5°. If the 0.5° API is exceeded, check the sample with another hydrometer. If the limit is still exceeded, the fuel should not be used until adequate technical advice and/or laboratory analysis has been obtained.

Testing Intervals. The appearance and gravity tests should be performed at the following intervals:

a. Daily, prior to starting fuel dispensing.

b. Before dispensing fuel from or through a new dispensing system component.

c. When a new fuel grade is being handled.

d. When any doubt of fuel quality exists.

e. After recirculation of fuel.

Specific and API Gravity Ranges for Fuels
(Corrected to 60° F)

Grade	Specific gravity range*	API gravity range	Pounds per U.S. gallons**
80/87	0.72 - 0.685	68 - 72	5.861
100/130	0.727 - 0.689	63 - 74	5.928
115/145	0.716 - 0.685	66 - 75	5.837
JP-4	0.8017 - 0.7507	45 - 57	6.618
JP-5	0.8448 - 0.7883	36 - 48	6.830

*Estimated range.

**Based on average API gravity and to be used for estimating only.

API Gravity groups

Group No	Coefficient of Expansion	Corresponding degrees API	Range of group (Degrees API/60°)	Products normally in group
0	.00035	8	Up to 14.9	Heavy crude oils
1	.0004	22	15.0 to 34.9	Light crude oils Residual fuel oils (NSFO, FS Grades 4, 5, 6). Lubricating oils
2	.0005	44	35.0 to 50.9	Kerosene Heavy diesel fuels Solvents Jet fuels
3	.0006	58	51.0 to 63.9	Motor gasolines Light diesel fuels
4	.0007	72	64.0 to 78.9	Aviation gasolines
5	.0008	86	79.0 to 88.9	Liquefied gases
6	.00085	91	89.0 to 93.9	
7	.0009	97	94.0 to 99.9	

AIDS TO QUALITY CONTROL

Settling Time. After fresh stocks have been added, the maximum possible settling time should be allowed to allow water and solids to settle out. The following minimum times are recommended:

Three hours per foot of fuel depth for JP-5-type fuels.

One hour per foot of fuel depth for JP-4-type fuels and aviation gasolines.

Recirculation.

Recirculation is the process of transferring fuel from one part of a dispensing system, through every other part, into a empty or partially filled tank. Recirculation is used to remove as much water as possible from fuel. It also helps control existing gum and microbiological growth. Contamination possibility increases with idle time, but with tactical systems, periods of nonuse will seldom exceed 48 hours. So generally, pumping an amount of fuel equal to twice the amount in the installed hose will remove contaminants to an acceptable level. If a meter is installed, pump until twice the number of gallons in the hoses has been recirculated. With no meter installed, the time procedure below can be used.

A time for recirculation pumping can be determined as follows:

(1) Count and record the number of sections of installed hose of each size and length.

(2) Use the table below to find the total hose content in gallons. For example, if there are 15 sections of 6" x 50' hose, 21 sections of 4" x 50' hose, 12 sections of 2" x 50' hose, and 6 sections of 2" x 25' hose installed, the calculations, using the table below are:

Fuel Content of Hose*

Sections	6" x 50'	4" x 50'	2" x 50'	2" x 25'
1	73	33	9	4.5
2	146	66	18	9
3	219	99	27	13.5
4	292	132	36	18
5	365	165	45	22.5
6	438	198	54	27.5
7	511	231	63	31.5
8	584	264	72	36.0
9	657	297	81	40.5
10	730	330	90	45

*To nearest whole gallon

(3) The amount of fuel to be recirculated is twice the hose content, or 2 x 1,923 = 3,846 gallons.

(4) Divide the gallons to be pumped by the pumping rate in gallons per minute to find the pumping time in minutes. For the example above, if the pump is set for a delivery rate of 150 gallons per minute:

3,846 gallons - 150 gallons per minute = 25.6 minutes.

Rounding to the nearest minute, operate the pump for 26 minutes.

Acceptable recirculation procedures include any method of equipment connection that allows pumping fuel in a closed loop through every installed component (except gravity nozzles). The process and requirement applies to the TAFDS, AAFS, and refueler vehicles.

Recirculation is done at the times and on occasions specified in local regulations, but should always be done before beginning daily operation and before dispensing fuel when the equipment has not been used for defined periods in excess of 48 hours.

After recirculation, reconnect the system for dispensing, and take a fuel sample from a nozzle to make sure it passes the quality tests.

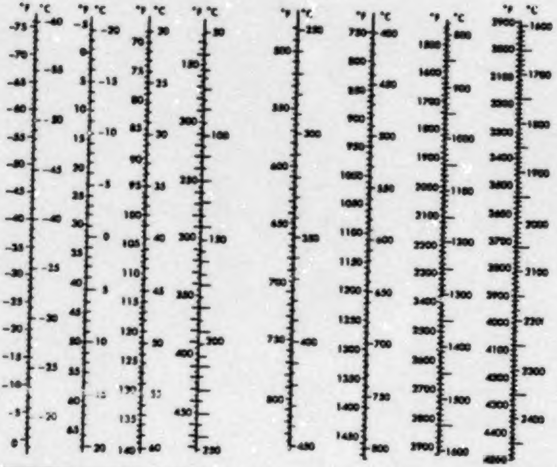
CONVERSION CHARTS

TEMPERATURE

TEMPERATURE CONVERSION

$C = 5/9\ (F - 32)$ 0 °C = 273.16 °K

$F = 9/5\ C + 32$ 0 °F = 459.688 °R



AREA

To convert	To	Multiply by
Acres	Square feet	43,560
	Square yards	4,840
	Square miles	0.0015625
	Square meters	4,046.873
	Hectares	0.4046873
Hectares	Square yards	11,959.85
	Acres	2.47104
	Square miles	0.003861
	Square meters	10,000
	Square kilometers	0.01
Square centimeters	Square feet	107,800
	Square feet	0.001076
	Square inches	0.1550
	Square meters	0.0001
	Square miles	3.861×10^{-11}
	Square millimeters	100
	Square yards	0.000196
Square feet	Acres	0.0000296
	Square centimeters	929.0
	Square meters	0.09290
	Square inches	144.0
	Square yards	0.11111
	Square miles	3.587×10^{-8}
	Square millimeters	9.29×10^{4}
Square inches	Square centimeters	6.452
	Square feet	0.6944
	Square millimeters	645.2
	Square yards	0.000716
Square kilometers	Acres	247.1
	Square centimeters	10^{10}
	Square feet	10.76×10^{6}
	Square inches	1.550×10^{9}
	Square meters	10^{6}
	Square miles	0.3861
	Square yards	1.196×10^{6}
Square meters	Acres	0.0002471
	Square centimeters	10,000
	Square feet	10.76
	Square inches	1,550
	Square miles	3.861×10^{-7}
	Square millimeters	10^{6}
	Square yards	1.196
Square miles	Acres	640.00
	Square feet	27.88×10^{6}
	Square kilometers	2.590
	Square meters	2.590×10^{6}
	Square yards	3.098×10^{6}
Square yards	Acres	0.0002066
	Square centimeters	8,361
	Square feet	9.0
	Square inches	1,296
	Square meters	0.8361
	Square miles	3.228×10^{-7}
	Square millimeters	8.361×10^{5}

FLOW

To convert	To	Multiply by
Barrels/day	G. p. h.	1.75
	G. p. m.	0.0292
Barrels/hour	Cu ft/min	0.0936
	G. p. m.	0.7
Gallons/hour	Cu ft/hr	0.1337
	Cu ft/min	0.002228
	G. p. m.	0.016667
Gallons per minute	Bbl/day	34.2857
	Bbl/hr	1.4286
	Bbl/min	0.02381
	Cu ft/day	192.50
	Cu ft/min	0.1337
	Gal/day	1,440.0
	Liters/sec	0.6308
	Cu ft/sec	0.002228
Cu ft/min	Gal/sec	0.1247
	Liters/sec	0.4720
	Cubic centimeters/sec	472.0
Cu ft/sec	Million gals/day	0.646317
	Gals/min	448.831
Cu yards/min	Cu ft/sec	0.45
	Gals/sec	3.367
	Liters/sec	12.74
Liters/min	Cu ft/sec	0.0005886
	Gals/sec	0.004403

LENGTH

To convert	To	Multiply by
Centimeters	Feet	0.03281
	Inches	0.3937
	Kilometers	1 x 10^{-5}
	Meters	0.01
	Miles	6.214 x 10^{-6}
	Millimeters	10.0
	Mils	393.7
	Yards	0.01094
	Microns	10,000
Feet	Centimeters	30.48
	Kilometers	0.0003048
	Meters	0.3048
	Miles (Nautical)	0.0001645
	Miles (Statute)	0.0001894
	Millimeters	304.8
	Mils	12,000
	Microns	30,480.0
Kilometers	Centimeters	1 x 10^{5}
	Feet	3,281
	Inches	39,370.0
	Meters	1,000.0
	Miles	0.6214
	Millimeters	10^{6}
	Yards	1,094
League	Miles	3
Meters	Centimeters	100
	Feet	3.281
	Inches	39.37
	Kilometers	0.001
	Miles (Nautical)	0.0005396
	Miles (Statute)	0.0006214
	Millimeters	1,000.0
	Yards	1.094
	Microns	1 x 10^{6}
Miles (Nautical)	Feet	6,080.27
	Kilometers	1.853
	Meters	1,853.0
	Miles (Statute)	1.1516
	Yards	2,027
Miles (Statute)	Centimeters	1.609 x 10^{5}
	Feet	5,280
	Inches	63,360.0
	Kilometers	1.609
	Meters	1,609.0
	Miles (Nautical)	0.8684
	Yards	1,760
Millimeters	Centimeters	0.1
	Feet	0.003281
	Inches	0.03937
	Kilometers	10^{-6}
	Meters	0.001
Millimeters	Miles	6.214 x 10^{-7}
	Mils	39.37
	Yards	0.001094
	Microns	1,000
Microns	Centimeters	1 x 10^{-4}
	Inches	3.937 x 10^{-5}
	Meters	1 x 10^{-6}
Yards (US)	Centimeters	91.4402
	Fathoms	0.05
	Feet	3
	Inches	36

LENGTH (Continued)

To convert	To	Multiply by
	Meters	0.9144
	Miles	5.68182×10^{-4}

VOLUME

To convert	To	Multiply by
Barrels (US)	US gallons	42
	Cubic inches	9,702
	Cubic feet	5.6146
	Imperial gallons	34.9726
	Liters	158.984
	Cubic meters	0.15899
Cubic centimeters	Cubic feet	3.531×10^{-5}
	Cubic inches	0.06102
	Cubic meters	10^{-6}
	Cubic yards	1.308×10^{-6}
	Gallons (US liquid)	0.0002642
	Liters	0.001
	Pints (US liquid)	0.002113
	Quarts (US liquid)	0.001057
Cubic feet	Cubic centimeters	28,320.00
	Cubic inches	1,728.00
	Cubic meters	0.02832
	Cubic yards	0.03704
Cubic feet	Gallons (US liquid)	7.48052
	Liters	28.32
	Pints (US liquid)	59.84
	Quarts (US liquid)	29.92
Cubic inches	Cubic centimeters	16.39
	Cubic feet	5.787×10^{-4}
	Cubic meters	1.639×10^{-5}
	Cubic yards	2.143×10^{-5}
	Cubic gallons	0.004329
	Liters	0.01639
	Mil feet	1.061×10^{5}
	Pints (US liquid)	0.03463
	Quarts (US liquid)	0.01732
Cubic meters	Bushels (dry)	28.38
	Cubic centimeters	1×10^{6}
	Cubic feet	35.31
	Cubic inches	61.023
Cubic meters	Cubic yards	1.308
	Gallons (US liquid)	264.2
	Liters	1,000

VOLUME (Continued)

To convert	To	Multiply by
	Pints (US liquid)	2,113.0
	Quarts (US liquid)	1,057.0
Cubic yards	Cubic centimeters	7.646×10^5
	Cubic feet	27.0
	Cubic inches	46,656
	Cubic meters	0.7646
	Cubic gallons	202.0
	Liters	764.6
	Pints (US liquid)	1,615.9
Gallons (Imperial)..........	Quarts (US liquid)	807.9
	Cubic inches	277.42
	Cubic feet	0.160544
	US gallons	1.20094
	US barrels	0.028504
	Liters	4.54596
	Cubic meters	0.004546
Gallons (US)...............	Cubic centimeters	3,785.0
	Cubic feet	0.1337
	Cubic inches	231.0
	Cubic meters	0.003785
	Cubic yards	0.004951
	Liters	3.785
	Pints	8.0
	Quarts	4.0
Gills	Liters	0.1183
	Pints (liquid)	0.25
Liters	Bushels (US dry)	0.02838
	Cubic centimeters	1,000.0
	Cubic feet	0.03531
	Cubic inches	61.02
	Cubic meters	0.001
	Cubic yards	0.001308
	Gallons (US liquid)	0.2642
	Pints (US liquid)	2.113
	Quarts (US liquid)	1.057

FORCE

To convert	To	Multiply by
Pounds per square inch ...	Kilograms per sq. m.	703.06687
	Inch of mercury	2.036009
	Feet of water	2.306009
	Atmospheres	.0680457
	Kilogram per sq. cm.	.07036
Kilograms per sq. m.	Pounds per sq. inch	.00142234
	Pounds per sq. foot	.2048169
	Inches of mercury	.0028959
	Feet of water	.003280833

WEIGHTS

To convert	To	Multiply by
Pounds (avoirdupois)	Grams	453.59
	Kilogram	.45359
	Ounces (avoirdupois)	16
	Ounces (troy)	14.5833
Pounds (avoirdupois)	Long tons	4.4643×10^{-4}
	Short tons	5×10^{-4}
Short tons	Kilograms	907.185
	Long tons	.892857
	Metric tons	.907185
	Pounds	2,000.00
Kilograms	Pounds	2.20462
	Short tons	0.0011023
	Metric tons	0.001
	Long tons	9.842×10^{-4}
Long tons	Kilogram	1,016.05
	Metric tons	1.01605
	Pounds	2,240
	Short tons	1.12
Metric tons	Kilogram	1,000
	Long tons	0.98421
	Pounds	2,204.6
	Short tons	1.10231

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